

# Engineering Record

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## The Chemists

LAST WEEK a suggestion was made in New York that the chemists should be brought into closer fellowship with the engineers, and that one way of bringing this about would be to have them take quarters in the Engineering Societies Building. The suggestion, it seems to this journal, is a most happy one. To dilate upon the interdependence of chemistry and engineering is to insult the intelligence of engineering readers. The interdependence is such as to need no demonstration. Why, then, should not a closer relationship be developed between the chemists and engineers as citizens interested in the industrial welfare of our country, as technical men imbued with the same high ideals and working to the same common end—maximum efficiency in the use of our natural resources? We trust that the movement will rapidly gather strength, that the close scientific relation between the two fields will quickly be paralleled by equally close society and personal relations. The engineers know that they would be benefited; we trust that the chemists will see equal, or at least very considerable, advantages.

## Professional Unity

WE are moving fast. Even the most casual observer cannot help but notice that never has there been such rapid progress toward professional unity, toward forms of activities which would give the engineer a large place in the nation's life. Never before have local engineering societies done such excellent work. Never have their members, through committees and civic organizations, helped so much toward the solution of public problems of an engineering character. Nationally, the clearest index of the present professional disposition is the determination of the American Society of Civil Engineers to join with the other three leading engineering societies in a common home in New York City. The Naval Consulting Board demonstrated in a public way what the engineers could do on a public problem. Now there is a movement on foot to continue its organization in order that the engineer may exercise a larger influence on public life. Nor is the advance movement confined entirely within the profession. As briefly stated in this journal on Sept. 23, conferences are under way between engineers, the applied scientists and the pure scientists looking for closer co-operation on matters that affect the public good. The chemists have been members of the Naval Consulting Board, and now it is informally proposed that they be invited to make their home with the engineers in the United Societies Building. Truly these are great days for the profession and, clearly, we are

merely at the beginning of things. We are only laying the groundwork. What will be the superstructure?

## Uniform Highway Cost Accounting

TIME and again at highway conventions one hears on the floor and in the corridors talk about the cost of work. Invariably explanation of the units and additional data are asked for in order that listeners may translate the figures into a form comparable with their own cost records. In other words, there is need for a standard method of reporting highway construction costs. It does not matter so much what the units are or what the method of subdivision is. Uniformity of records is the important consideration. There is now a means by which uniformity in these costs can be brought about. The Office of Public Roads specifies in the rules under which the \$75,000,000 federal-aid appropriation will be expended that it may require unit costs be kept on any project on forms supplied by the office. Since all states will probably take advantage of the federal appropriation the government's form will come to their attention and will necessarily influence the cost-keeping records. The form has not yet been determined upon, but doubtless, with the experience of the office, it will adequately fit the needs of highway engineers and contractors. It will be a boon to the road-building art if through this means a standard method of reporting road costs is adopted by the highway organizations of this country.

## Concrete Road Resurfacing

HAVING been a pioneer in concrete road building, Wayne County, Michigan, has been looked upon as a source of information on good concrete road practice. It has developed systems and methods, has experimented and tried out processes in order to select anything that would allow it to improve on its construction standards. Those interested in the possibilities of concrete in road improvement will watch with interest another of Wayne County's pioneer steps—the using of concrete as a resurfacing material. No concrete roads in Wayne County have as yet worn out, but Edward N. Hines, who is responsible for the experiment, realizes that some day perhaps a concrete road may need restoration, and his faith in concrete is such as to make him believe that nothing will restore such a road so well as the original material. The details are described on page 434. A 3-inch slab reinforced and of such a rich mixture as 1:1½:2½ is a pretty husky wearing surface. Many of the California roads laid on earth are only 1 in. thicker. The work should be looked upon in its true

light. It is an experiment and should be regarded as such for some time to come. The cost for the job described is not as low as might be desired. The construction is as yet only an experiment and standardized methods once evolved, provided the experiment proves itself worthy and graduates into standard practice, will probably reduce the cost to a reasonable figure.

## New York Sympathetic Strike

BRIEF mention was made in this journal last week of the threat made at New York City to call out all union labor in sympathy with the strikers of the city's electric transportation lines. The call involved approximately three-quarters of a million workers. It was predicted last week that less than 200,000 would go out. As a matter of fact, the number was only about 60,000—a clear demonstration that labor thinks for itself, that those who have contracts with employers will carry them out regardless of the dictates of irresponsible leaders. The federal precedent emboldened the leaders to make the try. It was not sufficiently influential, however, with the rank and file to tie up the whole industrial life of New York.

## Business and Engineering

IN the offer of a money prize by the engineers' subdivision of the Chicago Association of Commerce for papers which will make the young engineer early grasp his relation to the business and professional world there is more significance than appears on the surface. The great portion of the work of this association, which is conceded to be a model for all other similar organizations, is done largely by committees, but the membership is divided into seventy-eight sub-divisions according to business affiliations. The engineers hold meetings at regular intervals throughout the year to discuss business problems of the profession. Among the topics to which attention keeps reverting are the education of public officials and laymen in engineering and the advantages of employing real engineers. Finally it was concluded to attempt to encourage as many of the younger men as possible in the process of doing the educating. The efforts put forth will be a better reward to the men participating than the actual prizes. Only after several months' consideration by a committee of the brainiest business men in Chicago was the prize money appropriated. To devote money to such a purpose was creating a new precedent, and they wanted to be sure it was a good one. When business comes half way or more to meet the young engineer he should appreciate and welcome his opportunity. May the papers be numerous.

## Commercial Possibilities with Activated-Sewage Sludge

FROM statements made before the American Chemical Society at its convention in New York last week it appears that the recovery of nitrogen, as a fertilizer base, from sewage sludge, on a commercially practicable scale, is at last well within the range of actual accomplishment. The announcement is of signal importance, and its influence will be felt far beyond the field of sanitary engineering. The facts upon which this prediction is made are contained in the paper, on page 444, by William R. Copeland, chemist in charge of the Milwaukee Sewage Testing Station, which is followed (page 445) by a discussion by George W. Fuller, consulting engineer, New York City. Of course, everyone has known that sewage contains valuable chemical ingredients hitherto allowed to run to waste, and it is not news, either, to learn that nitrogen may be extracted from sludge. The outstanding feature of Mr. Copeland's investigation, however, is that this result appears now to be commercially practicable.

In the earlier types of sewage treatment plant plain sedimentation or septicization was resorted to. Then came the Imhoff tank, with its separation of settling and sludge-digestion chambers. In all of these processes the nitrogen content of the sludge amounted to only from 1.2 to 3 per cent—much less than would be expected from the composition of the raw sewage. This diminution of nitrogen, however, is readily accounted for by the nature of the process of treatment. Some of it passed away in the form of colloidal matter with the tank effluent and a substantial portion was lost by conversion into gases which escaped directly to the atmosphere. With the newer form of sewage treatment by the activated-sludge method these channels of escape for the nitrogen are effectively blocked, for one of the distinctive features of the process is that nitrogen-carrying colloidal and suspended matters of the sewage are collected in the sludge.

The Milwaukee data show that dry sludge from the activated-sludge process contains about twice as much nitrogen as the sludge from other processes. In this condition we have the master key with which to unlock the treasure stored up in sewage sludge. On a basis of 10 per cent moisture the activated sludge at Milwaukee shows a nitrogen content, figured as ammonia, of from 4.6 to 5 per cent, as against only  $1\frac{1}{2}$  to 3 per cent of nitrogen from sludges produced by other processes. At present prices nitrogen, according to Mr. Copeland, is worth \$2.50 per unit, or per cent. In normal times the value of this product would be about \$2 per unit. Summing up the situation Mr. Copeland's figures indicate that the dried sludge from the activated process (10 per cent moisture) is worth from \$9 to \$15 per ton, while the total cost of getting this product and placing it on the market, including all overhead expenses, will range from \$8 to \$12 per ton. It is pointed out, also, that this cost may be materially reduced in the case of large plants.

If sewage treatment plants can be made to produce, at a profit, nitrogen as a base for high-grade fertilizers their field of usefulness will be very materially widened. Reduced operating costs certainly will have a decided influence in stimulating sewage plant construction, with a consequent reduction in the number of nuisance-producing water courses throughout the country. It may be, therefore, that the Milwaukee work foreshadows a sanitary improvement program of national proportions.

## Will It Rise to Its Opportunity?

NEXT WEEK the American Society of Municipal Improvements will meet in Newark, N. J. Will it take the steps needed to place its work on the high plane of our other national engineering societies?

As at present conducted, its procedure in the making of specifications is a reflection on the American engineering profession. Specification-making, when a part of the function of any society, is considered one of its most important activities. Consequently in organizations of recognized standing a practice has grown up which insures the very closest scrutiny of proposed specifications in order that the final result may represent the best work of the organization and that all possible flaws will be detected and all objections calmly considered.

The American Society for Testing Materials is the leading engineering body in this country which formulates and adopts specifications. When a new subject is to be taken up its procedure is to appoint a committee. This body, after due consideration, brings in a tentative specification, which must run the following gauntlet before final adoption:

1. Publication in advance of an annual meeting.
2. Consideration at that meeting. The meeting may either refer the specification back to the committee, or may order it printed in the year book as a tentative specification for a two-year period.
3. Consideration in an annual meeting two years later. In the intervening two years amendments may have been proposed and changes made. In that event the specification, as amended and changed, is printed in advance of the second meeting.
4. Consideration at this second meeting, at which the specification may be again referred back to the committee or may be passed to letter ballot of the members.
5. Approval by letter ballot, in which each member of the society is entitled to vote.

It is patent that this procedure gives an opportunity for all objections to be heard and every clause to be scrutinized. There can be no star-chambering. There can be no manipulation by manufacturers without the fact becoming known. It is this careful procedure which has given the work of the American Society for Testing Materials so enviable a standing.

Contrast this deliberate, careful policy with that of the American Society of

Municipal Improvements. The *Proceedings* of the 1915 convention of that society, pages 535 and 536, lays down the following procedure: "That the president direct the subcommittees to consider more fully their reports prior to the date of the convention and that the chairman of each committee transmit an advance copy of his report for publication with the advance copies of papers; also that the subcommittees meet on the day preceding the first day of the convention and report to the general committee on the first or second day of the convention. And that when a majority of the subcommittee is not in attendance at the convention the president be authorized to appoint additional members of such subcommittees from the members present." The general committee referred to is a board of five on standard specifications, which sits at convention time to pass on the work of its subcommittees.

This procedure is merely suggestive; it is not obligatory. There is no compulsory advance printing, so that the membership may carefully scrutinize what they will be expected to vote upon. As a matter of fact, in the past it has not been unusual for members of subcommittees to have no specifications ready previous to their appearance in the convention city. Everything is done with a rush, without that calm consideration, that openness which is absolutely essential if the engineering public is to have respect for the result. We submit that even experienced engineers are not competent in a day or two to pass judgment on a complicated specification. It needs study. It needs analysis. Both are impossible in the brief sittings of the committees.

Moreover, there are necessarily commercial interests involved in some of the specifications. Since they are not published in advance rival manufacturers find it necessary to come in force to fight for what they consider their rights. As a result, the commercial brawls at the conventions have been nothing short of disgraceful.

But some will contend that no bad specifications have been adopted. Even should that be the case, thanks are not due to the system or to the scrutiny of the membership but rather to the ability of a few able men and to the strenuous fights of rival manufacturers. Those who want some light on the society's procedure are advised to read the discussion on pages 522 to 529 and 537 to 553 of the *Proceedings* of the Dayton meeting. They tell about the adoption of a patented specification as one of the standards of the society.

The American Society of Municipal Improvements can become a force for great good, and that is why the Engineering Record urges the reform of its procedure. So long as it follows its present course it will be distrusted by the profession, and the fine work it is doing in the presentation of technical papers will be more than counterbalanced and vitiated. This year while its program is absurdly long, it presents some very excellent material. It is regrettable that its specification-making procedure does not comport with the excellence of its other work.

## Engineering Expression on Public Questions

THE Council of National Defense, established by federal law, has taken over the work of the Naval Consulting Board, and that body's organization, therefore, is ready for dissolution. It has performed a great public work. It has demonstrated what an influence engineers are capable of exercising and what work they can do on public problems of an engineering character.

Shall that organization, formed and equipped to carry out the engineers' part in a great national work, be disbanded? Or shall it be made the agency through which the engineer henceforth will project himself into public affairs? These are the questions that were raised last week in New York City before a group of representative engineers called together by W. L. Saunders.

At the outset, let us lay down the proposition that the engineer needs some agency for public expression. That, the Engineering Record holds, is no longer open for discussion. The engineering profession has indicated clearly its attitude by its approval of the public activities of local and national engineering societies.

Then remains the question, What shall that agency be?

At first blush, most engineers, we believe, will object to the establishment of a new organization. They will feel that the existing national bodies should be the agency for expression. These bodies are well established. Their memberships are large and representative. Their standing is of the highest. Their organizations have been perfected.

Can the national engineering societies be brought to play their part in such a program of public expression? That question points to the difficulty of relying upon the national engineering societies to do this work. Their expressed object is to advance professional knowledge and to secure the maintenance of high standards in the profession. Their activities, however, have kept pace with the times; their constitutions have not. Despite their activities in public affairs, there is undoubtedly a large number of their members who are not yet won over to the new point of view, and who would especially object to the virile work that needs to be done. In time, no doubt, the entire membership will favor more active participation in public affairs.

While the Naval Consulting Board's organization would be untrammelled by precedent, and would have public activity as its main object, there would be some difficulties in its way. While no one would be eligible to membership in the new body unless he belonged to one of the national engineering bodies, the new organization could not have the prestige of the existing ones. Its membership would be smaller and less representative. Much would need to be done to knit it together and to recruit a membership large enough to be effective.

Something should be done; some agency provided to bring the engineers' influence to bear on our national life. If the com-

mittee appointed at Mr. Saunders' meeting believes, on inquiry, that the national societies will not assume the function and agree to exercise it with vigor, then there is call for perpetuation of the Naval Consulting Board's organization. At best, however, in the judgment of the Engineering Record, that organization would be a temporary one, and, if formed, should stand ready a few years hence to pass back to the national societies this public service function which they, better than any other body, can exercise.

## All the Evidence In on the Quebec Bridge Case

SINCE the loss of the suspended span of the Quebec Bridge on Sept. 11 two principal explanations have been offered by correspondents of this journal for the initial failure. The first was that the sections of the rocker-joint castings were insufficient or improper in design; the second, that the support was in unstable equilibrium.

Instead of printing these discussions, all of which were prepared without full data as to the details of the rocker-joint and of the lower ends of the lifting stirrup, the Engineering Record considered it better to withhold them until all the evidence was presented. In this issue the remaining pertinent data are published.

Before entering on a brief discussion of the data, the Engineering Record wishes to put on record the candor with which the Board of Engineers and the officers of the St. Lawrence Bridge Company have met every inquiry regarding the accident. Everything asked for has been given; every facility afforded to put the profession in possession of information that might shed light on the cause of failure.

As to the castings, the tests and analysis of specimens leave no ground for criticism as to the character of the metal. The composition is up to specifications; the strength and ductility very satisfactory. There were no rejections, and the inspection was careful. No details are available to show the history of the annealing; the usual practice of the Canadian Steel Foundries, Ltd., which furnished the castings, was followed.

The computations reveal an interesting condition. If the load were to be carried entirely in direct compression the stresses that would have developed in an intermediate casting without wings would be well within the limits of good practice. Manifestly the design of an intermediate member that would act only in compression was out of the question. Longitudinal stability was required not only during hoisting, but while the span was on the bents at Sillery Cove. But the addition of the longitudinal wings actually weakened the casting, or, to put it in a better way, required the casting to take bending stresses. These were limited by the designers (with their assumption of stress distribution) to 20,000 lb. per square inch. It will be noted that these stresses are checked by an alternative assumption as to stress distribution. The factor of safety, however, it

seems to this journal, was too low for a member in such a responsible position and made of such material. The success of the whole unprecedented hoisting operation was directly involved.

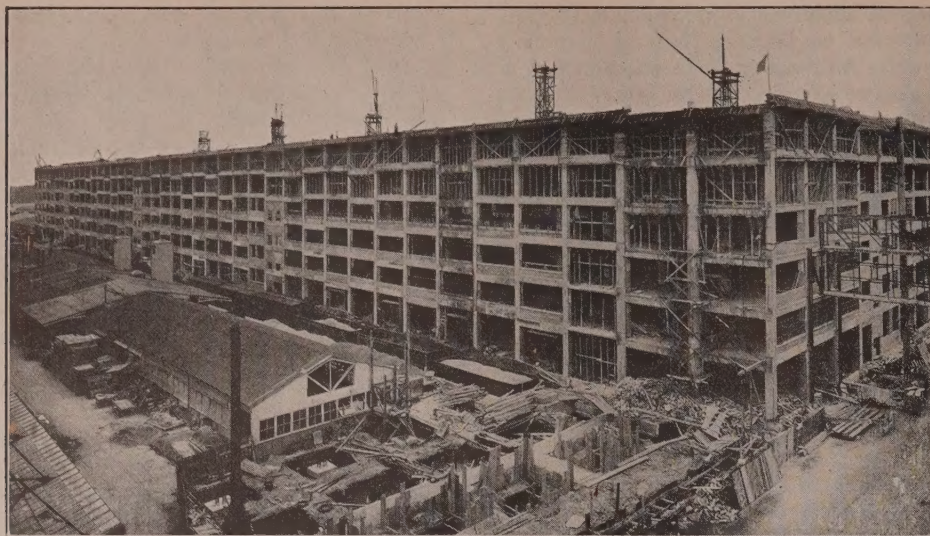
While, in the opinion of this journal, a higher factor of safety would have been advisable, the only conclusion that seems warranted is that the failure was due to a defect in the metal.

The second explanation of the initial cause of failure has been that the support was in unstable equilibrium. The drawings shown elsewhere in this issue indicate that the lowest pin of the stirrup system was but  $3\frac{1}{2}$  in. above the transverse pin between the suspended span and the intermediate casting. There was a large pin through diaphragms in the lifting girder itself, but movement about this pin was effectively prevented by the connections between the stub link and the cover plates of the girders.

With the very small vertical distance,  $3\frac{1}{2}$  in., between the lower pin of the suspended span and the transverse pin carrying the span, any error in exactly centering the latter pin and castings on the supporting girder would tend to tip the latter and the stub link to which it was attached. Excess loading would therefore be thrown in one wing of the rocker casting, and the tipping would tend to cause the casting and span to slip off the greased longitudinal pin. Friction and the light  $\frac{3}{8}$ -in. centering plates only prevented slipping. Nevertheless, the system was in stable equilibrium, provided the central relation of all of the parts was maintained.

Furthermore, when the inquiry comes down to a review of the facts, as opposed to the theory of slippage, the answer can only be that slipping did not occur. We know positively, from the evidence afforded by the southwest lifting girder, that the span went off diagonally—that it did not slide off the hanger. Furthermore, the picture of the span going into the river, published in this journal Sept. 16, distinctly shows three of the corners seated on the girders, while the fourth corner, the southwest one, was under water and 60 to 70 ft. lower than the other three. Under very extreme conditions, therefore, the supports held their load in place, even though the figures and the drawings show a dangerous dependence on pin friction and accuracy in shop work.

In the judgment of this journal the case of the suspended span of the Quebec Bridge is closed. Fortunately, sufficient evidence was preserved on the girder to show exactly what happened. This evidence, combined with the detailed drawings, leaves it to every engineer to draw his own conclusions. Some will believe, as does this journal, that greater factors of safety should have been used in the intermediate castings and the suspension details. While engineers are entitled to these beliefs, however, it should be distinctly borne in mind that under most severe punishment three of the intermediate castings proved their sufficiency, as did also the suspension details which have been called into question.



BY JULY 1, 640,000 SQUARE FEET OF SLAB HAD BEEN COMPLETED IN 34 WORKING DAYS

## Addition to Detroit Plant Sets New Mark for Rapid Concrete Construction

Six-Story Automobile Factory, 164 x 842 Feet, Completed with Three Concrete Mixers at a Rate Exceeding Construction of Philadelphia Building

EXTRAORDINARY speed, considerably exceeding that made in constructing the Baldwin Locomotive Works plant described in the Engineering Record of Aug. 5, 1916, page 160, was made in erecting the 842 x 164-ft. six-story reinforced-concrete addition to the Ford Motor Company's plant at Detroit, accepted from the builders, the George A. Fuller Company, on Aug. 1 last. Whereas the Baldwin plant, exclusive of the ground floor, contained 320,000 sq. ft. of slab, poured in 41 days elapsed time, the Ford plant on the same basis required 640,000 sq. ft. of slab, which was poured in 62 days elapsed time. In both cases the ground floor slab was also poured within this time. Owing to the fact that the operation of the existing plant could not be interfered with, only one end of the building was accessible to the contractor, and all the material required, amounting to more than 2000 carloads, had to be transported from this end through the center of the building on a double-track industrial railway. This layout was facilitated by a central craneway the length of the building, extending to the roof, in which were located three concrete towers and three brick hoists. Concrete was mixed at the base of each tower, the materials being delivered separately in cars. The record made in construction is the more remarkable because

the finish floors were laid homogeneously with the slab under Master Builders' specifications, and had to be allowed to harden 24 hours and covered with shavings before the next tier forms could be started. Moreover, slotted inserts, crossing the width of the building every 6 ft., had to be set and leveled.

### FOOTING CONSTRUCTION REQUIRES 43 DAYS

Ground for the building was broken on March 19 last. Unsatisfactory soil conditions developed, however, which delayed the completion of the footings until May 1. It was found advisable to lower the footings in some cases to a depth of 25 ft. below the lot level, and a total of 18,000 cu. yd. of excavation was required. The only form work completed before May 1 was a few parts of the first tier, and no concrete above the footings had been poured. The concrete work was entirely completed on July 1, including the roof, which was particularly difficult to form because of the complicated concrete beam work necessary for the craneway and craneway skylight. This skylight itself is carried on steel trusses.

The building was planned in general with panels 22 ft. square and with uniform 12-ft. story heights. Also, practically the entire space between the exterior columns and the spandrel beams at the outside edges of the

floor slabs was filled with steel sash to give the maximum amount of light. On the other hand, in addition to the difficulties with forming the skylight and craneway beams, the columns were hollow cylinders reinforced on each face with spiral steel. This construction permitted carrying the ventilating ducts in the columns. Moreover, the lighting and power conduits were carried in the slab, there being more than 6000 floor boxes. The floor slabs themselves were 8½ in. thick and of the mushroom type, with drop heads at the columns. While the interior columns were all round, the exterior and craneway columns were square. The columns also contain a large number of socket inserts. The heating and ventilating plant is installed in eight pent houses on the roof, and will be operated with steam from the company's main heating plant.

### INDUSTRIAL RAILWAY SUPPLIES MATERIALS

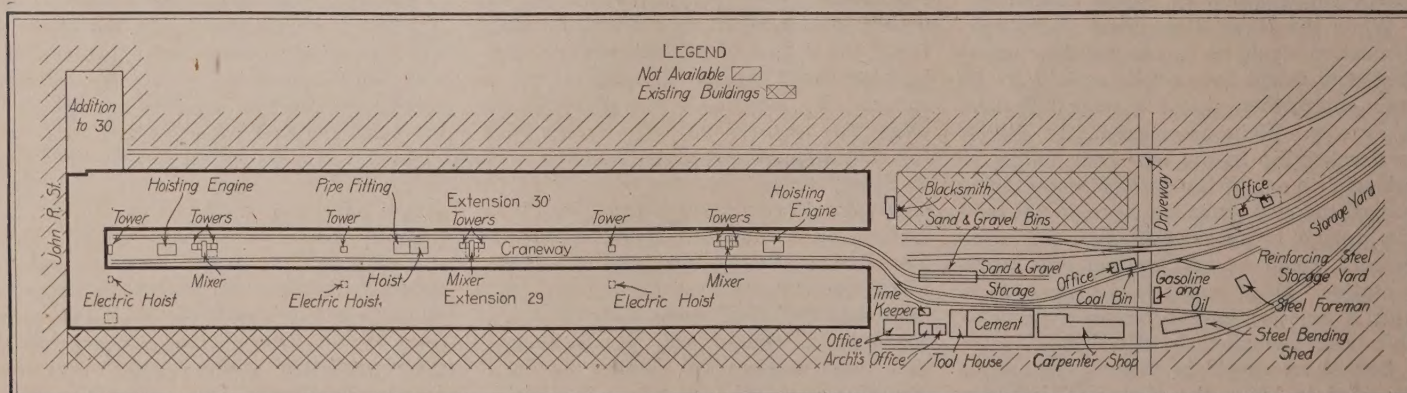
As may be seen from the layout drawing reproduced herewith, all the materials were received at one end of the building, and had to be conveyed through it on a double-track industrial railway. This railway supplied six towers located near the center line of the building in the craneway. Three of them at which mixing plants were located were used exclusively for handling concrete, while the other three were used as brick hoists, and mounted the booms which handled the reinforcing steel and forms.

It had been intended to place the ¾-yd. Smith mixers below ground at each of these towers so as to feed them by gravity. The soil conditions disclosed, however, made this impossible without running the risk of disturbing the soil under adjacent footings. Wheeling to the mixers was therefore necessary, but was reduced to a minimum by dumping the industrial trains as close as possible to the mixers. As may be seen from the drawing, these trains were loaded by gravity from sand and gravel bins which were filled from railroad cars by a locomotive crane with a grab bucket. Because existing railroad tracks made it difficult to locate the cement shed adjacent to the bins, it was necessary to distribute the cement in separate trains.

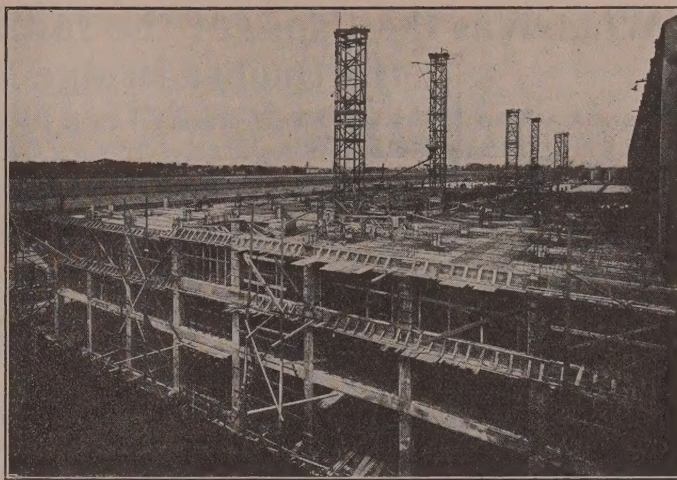
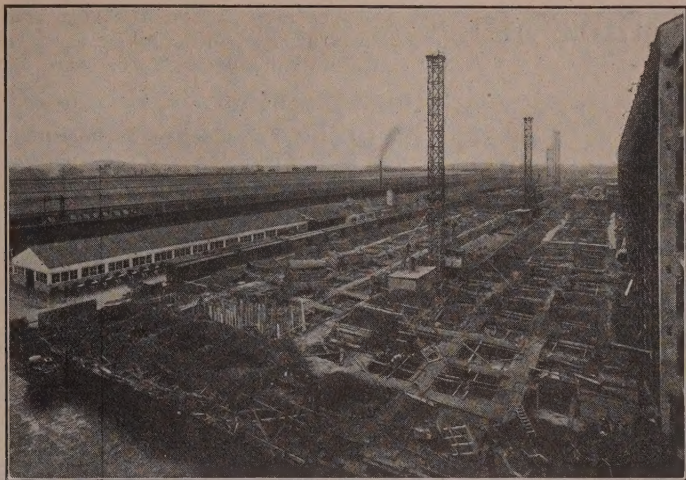
### THREE MIXING PLANTS USED

Three mixing plants were used in place of two of larger capacity, so that one mixer might be stopped at any time for overhauling without delaying the work. Each machine was inspected daily and kept to its maximum efficiency, and the usual delays from this source were entirely avoided. The concrete was spouted to hoppers on the floors and distributed by buggies.

It was necessary to unload all the rein-



OPERATION OF SURROUNDING AUTOMOBILE PLANT LEFT RESTRICTED YARD SPACE AND ALLOWED ACCESS TO BUILDING ONLY AT ONE END



THREE CONCRETE PLANTS IN CRANEWAY POURED ENTIRE BUILDING—FOOTING CONSTRUCTION AT LEFT; RIGHT SHOWS THIRD FLOOR FORMED

forcing steel about 400 ft. from the building, as indicated in the drawing. This also had to be delivered to the building by industrial cars. The two gasoline locomotives, made by the J. B. Fate Company, and the fourteen Lakewood cars which delivered all of the materials used in the building were, according to the contractor's statement, in as good condition at the end of the job as when purchased.

#### FORMS HANDLED IN PANELS

All of the wood forms, including those for the footings, were made in sectional panels at the mill on the site. These forms, in making which 2,000,000 ft. b.m. of lumber was used, were designed to facilitate stripping and re-erecting. Wood was used for all the form work except the interior circular columns, for which metal forms were employed.

Reshoring and its consequent loss of time were entirely avoided by designing the panel forms for the decking so that the slab

could be stripped without disturbing one line of shores. Cast-iron chairs were used to support the reinforcing bars and also the wood screed for floor finish.

#### NIGHT WORK AVOIDED

It was necessary to employ two shifts of concrete finishers and concrete gangs, but other trades worked only a single shift. A force of nearly 2000 men was employed. The operations of setting forms, steel and floor inserts and pouring concrete followed so closely that each operation was in continuous progress on two floors at all times. Concrete was poured at an average rate of nearly 1000 cu. yd. per day.

As compared with 25 days actual working time on the Baldwin plant at Philadelphia, the actual working time on the Ford Building was 34 days, 28 of the 62 days elapsed time having been lost through rain, Sundays and one holiday. Exclusive of the roof, the actual number of square feet formed and poured each working day was

21,000. The difficulty of constructing the roof forms brought this average down to 18,500 ft. for the entire building. This compares with 12,800 sq. ft. per working day averaged at the Philadelphia building, not counting in either case the ground-floor slab.

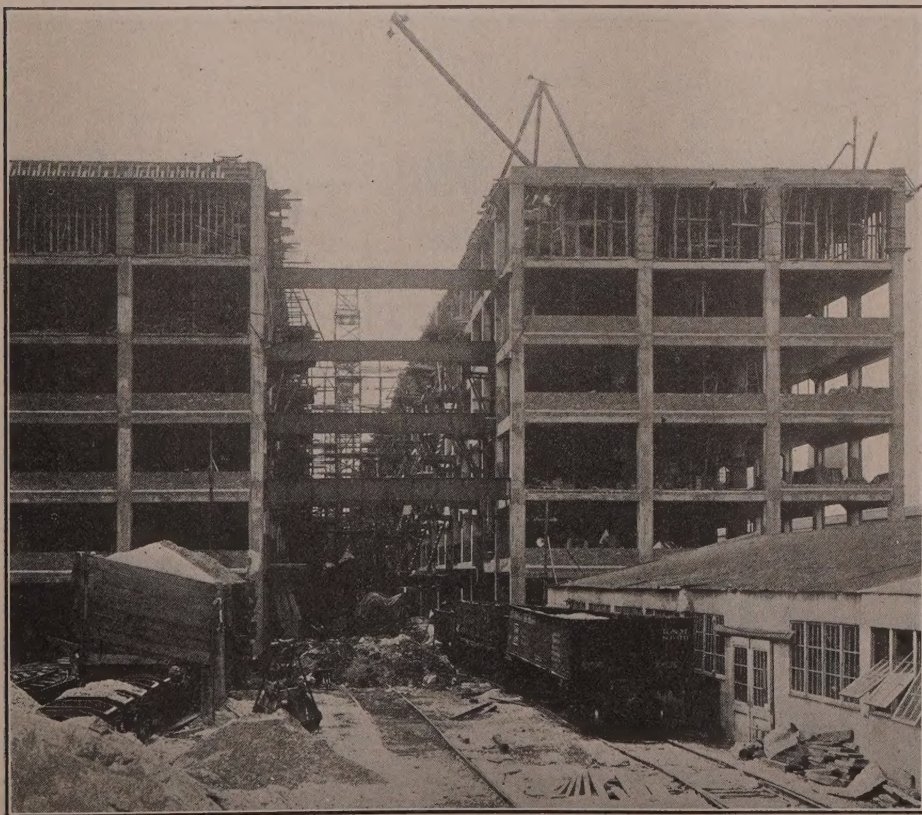
The building, including both engineering and mechanical features, was designed by Albert Kahn, architect, of Detroit, and built under his supervision by the George A. Fuller Company, with A. G. Cassel as superintendent and David Shearer as assistant superintendent. Frank Bailey represented the architect on the work.

#### Cheaper to Build the New Than Maintain the Old

THERE has been discussion in recent years on the great need of a deep-water channel to connect Sacramento, Cal., with the sea. The city lies about 50 miles by river from Suisun Bay, an arm of San Francisco Bay, and it has been maintained that a deep-water route is one of the city's greatest needs.

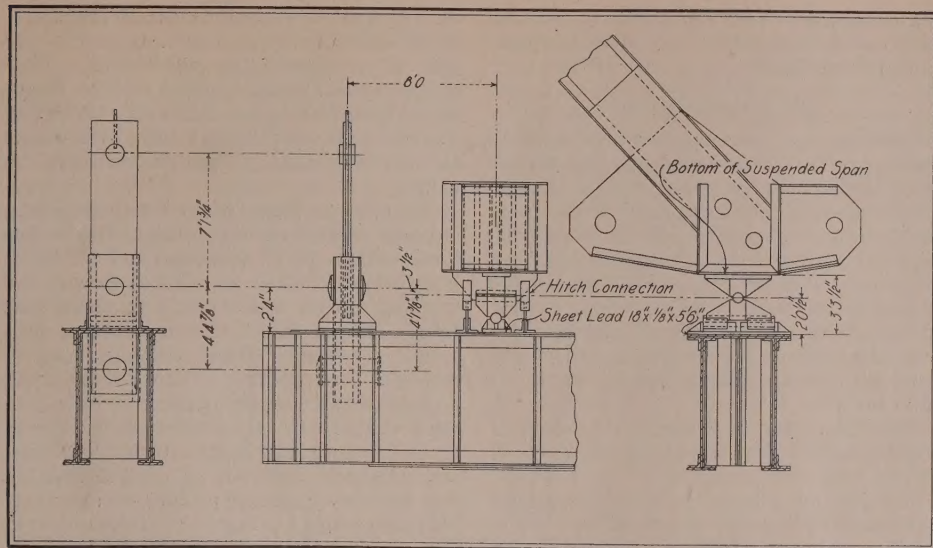
The Sacramento River, which passes through the city and flows directly into Suisun Bay, has been many times surveyed, and United States engineers have estimated that it would cost about \$400,000 a year to maintain a 15-ft. channel to the bay. But this depth is not considered sufficient, and surveys made under the direction of the state engineering department are reported to indicate that the maintenance of a 30-ft. channel would be about \$1,000,000 per annum.

Because this annual expenditure was considered unwarranted, an examination of other means of accomplishing the same end was undertaken. It was found that a ship canal could be built from the south border of the city, a distance of 35 miles, to deep water on the San Joaquin River, by way of the old city drainage ditch, Snodgrass and Georgiana sloughs. By using this route it will be possible to take advantage of natural waterways for 14 of the 35 miles, which will keep the total cost of excavation down to about \$1,000,000 for a 30-ft. canal with a bottom width of 150 ft. This figure would not, of course, include costs of right-of-way, wharves or other incidental work; but the ship canal would be practically free from the necessity of annual dredging to remove silt brought down during the flood-water stage, whereas dredging would be necessary in the river channel.



THESE TRACKS THROUGH CENTRAL CRANEWAY FURNISHED ONLY ACCESS TO BUILDING





LOCATION OF HANGER PINS, STUB LINK PINS, CASTINGS AND END PINS OF SPAN

ing without exceeding the allowable pin fiber stress, and the lower casting would distribute the load over 31.9 in. of the top of the stirrup girders. For the  $9\frac{1}{2}$ -in. pin actually used, these lengths are increased to 31.8 and 34.6 in. respectively. The actual dimensions of these castings are given on one of the drawings, and the details of the stirrup girders and diaphragms on another. The distance between the webs of the two girders of the stirrup support is seen to be 4 ft., the total length of the casting being 5 ft. 6 in.

The possibilities of exceeding the allowable fiber stresses in the castings and pins as actually detailed, based upon usual assumptions of uniform load distribution along the pin, are obvious. For example, as shown in the computations in the table, the unit fiber stress in the longitudinal wing, based upon a uniform distribution of 2,550,-

000 lb. (assuming the total weight at 5100 tons, without impact, as existing at the time of failure) over the 39.5 in. actual bearing length of the rocker casting, is found to be 38,400 lb. per square inch. If friction at 10 per cent on the transverse pin, due to deflection of the suspended span or other causes, be assumed to cause uniformly varying pressure on the longitudinal pin, a total of 42,400 lb. per square inch is obtained, which means a factor of safety of 1.65. As some of these castings probably carried twice this load without failure, it is evident that the assumed uniform distribution here discussed did not take place.

Assuming that the total load of 2,550,000 is distributed over the full 39.5-in. bearing of the rocker casting as a uniformly varying pressure from zero at the outer end to a uniform pressure for  $9\frac{1}{2}$  in. at the center, there is obtained a unit stress in the casting

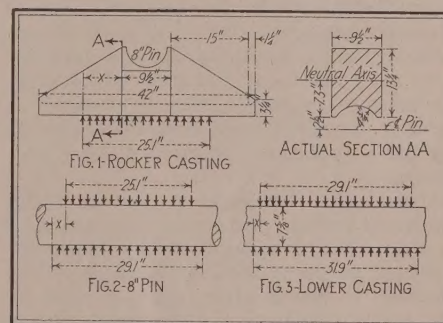
about equal to the allowable value of 20,000 lb. per square inch. It will be noted that the rocker casting would have had lower unit stress in bending if the longitudinal wings or arms had been made only about 25 in. long in bearing on the lower pin. The increase in length was made for the purpose of increasing the longitudinal stability.

The castings were furnished by the Longue Pointe plant of the Canadian Steel Foundries, Ltd. The metal was made by the acid open-hearth process. No castings were rejected, none were repaired, and they were inspected by both the bridge company's engineers and the Board of Engineers.

#### STABILITY

The question why a pin connection between the stub link and the supporting stirrup was adopted when a rigid attachment is furnished at the top of the girders, as shown in one of the drawings, is answered by the fact that these girders were first used as supports for the steel falsework framing and this pin joint was the detail there required. This also explains the sole plates on the ends of these girders. The question of stability is discussed editorially in this issue.

#### Computations for Load Distribution and Stresses



ROCKER CASTING (SEE FIG. 1)

$$\text{Load per unit length} = \frac{3,000,000}{9\frac{1}{2} + 2x}$$

$$M = \frac{3,000,000}{9\frac{1}{2} + 2x} \times \frac{x^2}{2}$$

$$\text{Section modulus} = 182.5$$

$$\text{Allowable } M = 20,000 \times 182.5 = 3,650,000$$

Therefore

$$\frac{3x^2}{19 + 4x} = 3.65$$

$$x = 7.8 \text{ in.}$$

$$\text{Casting distributes load over } 9.5 + (7.8 \times 2) = 25.1 \text{ in.}$$

$$\text{Bearing unit stress} = \frac{3,000,000}{25.1 \times 8} = 15,000 \text{ lb.}$$

8-INCH PIN (SEE FIG. 2)

$$M = 1,500,000 \times \frac{x}{2}$$

$$\text{Section modulus} = 50$$

$$\text{Allowable } M = 30,000 \times 50 = 1,500,000$$

Therefore

$$1.5 \times \frac{x}{2} = 1.5$$

$$x = 2 \text{ in.}$$

$$8\text{-in. pin distributes load over } 25.1 + (2 \times 2) = 29.1 \text{ in.}$$

LOWER CASTING (SEE FIG. 3)

$$M = 1,500,000 \times \frac{x}{2}$$

$$\text{Section modulus} = 52.3$$

$$\text{Allowable } M = 20,000 \times 52.3 = 1,046,000$$

Therefore

$$x = \frac{1.046}{1.5} \times 2 = 1.4 \text{ in.}$$

$$\text{Casting distributes load over } 29.1 + (1.4 \times 2) = 31.9 \text{ in.}$$

COMPUTED STRESS IN ROCKER CASTING  
(SEE SECTION AA, FIG. 1)

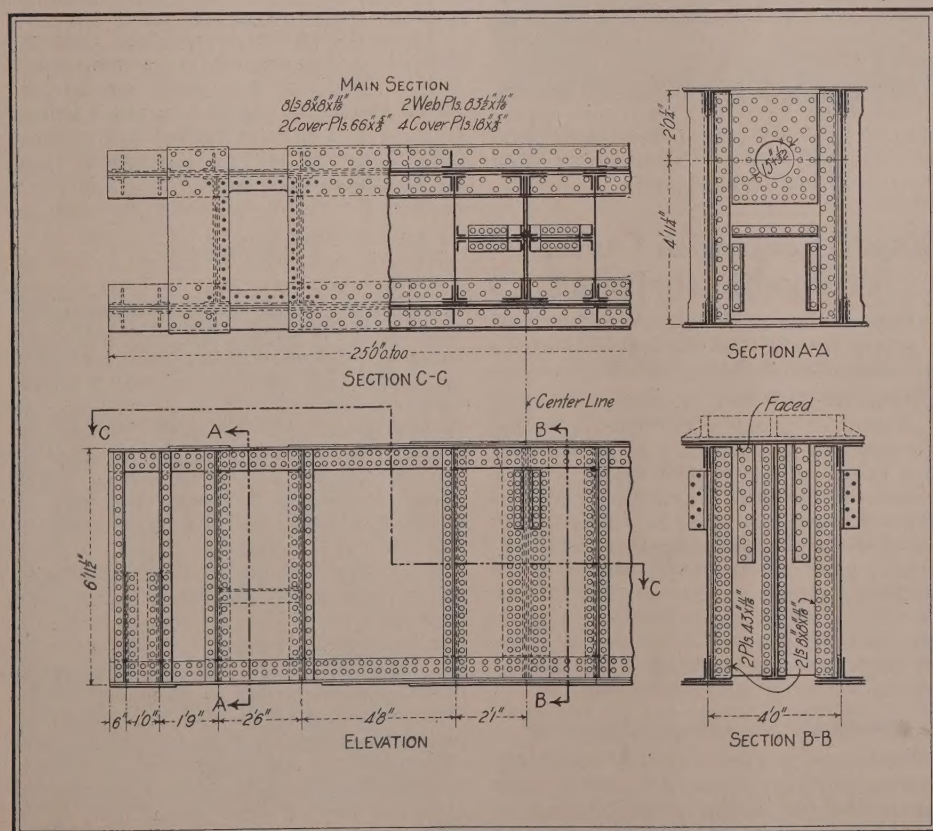
$$\text{Assuming } 2,550,000 \text{ lb. uniformly distributed}$$

$$\text{Load per unit length} = \frac{2,550,000}{39.5} = 64,500$$

$$M = \frac{64,500 \times 15^2}{2} = 7,260,000$$

$$\text{Section modulus} = \frac{1380}{7.3} = 189$$

$$\text{Tensile bending unit stress} = \frac{7,260,000}{189} = 38,400 \text{ lb.}$$



PART ELEVATION AND SECTIONS OF SUPPORTING STIRRUP WITH DIAPHRAGMS

## Oregon Engineer Discusses Personal Advertising

"Acquaintance of One Engineer Is Worth, to an Engineer, That of Half a Dozen Other Men"

HOW MANY ENGINEERS do you know and how many know you? How can your list of engineer acquaintances be broadened at not too great an expenditure? The answer, as given in the September *Bulletin* of the Oregon Society of Engineers, is: "Join a local engineering society." Don't stop at merely "joining," continues the article, but be a real live unit—get to know every other member. When there is a lecture, enter into a helpful discussion—even offer to give a lecture yourself and contribute to engineering publications. The editor of the *Bulletin* dwells more in detail on these subjects in the following quoted paragraphs. He says:

"Some of you may be old enough to remember the phrase, 'Keeping everlastingly at it brings success,' and to remember the little old-fashioned ads in which it appeared. Others may have absorbed the idea conveyed in that other slogan, 'It pays to advertise,' and yet have been unable to see where it has paid you.

"Many engineers have a notion that acquaintanceship with other engineers, while agreeable enough, so far as it goes, doesn't really amount to anything where dollars and cents are concerned; and these deluded individuals are expending their substance in 'putting up a front' and otherwise cultivating the acquaintance of men of other professions.

"Now I am not going to say anything against the other professions, nor the men in them, but I honestly believe that for practical purposes the acquaintance of one engineer is worth to an engineer that of half a dozen other men. In my own case it has proved true. Total strangers have walked into my office and given me better jobs than I knew were available—sent to me by engineer friends—while the best that I could get out of the other acquaintances might be a chance to stake out a lot—at half price—as a neighborly act, you know. And they make a fellow feel at the same time that they are giving him the work largely as an act of charity.

### SUGGESTS ENGINEERING CO-OPERATION

"There are four or five hundred engineers in and around Portland. How many of them do you know? How many of them know of you? If you were asked to design a bridge or a power station, and were too busy or didn't know how, could you recommend a man to do the work? Or to reverse the case, how many of the five hundred engineers in this vicinity know your specialty and your qualifications?

"I'm willing to bet that they are mighty few. Maybe it is just as well, too, for frequently those who know me tell me that I have missed my calling; and they may be right about it. Quien sabe?

"You may have missed your calling, also, in which case the greater the secrecy surrounding you, the greater will be your chances of success as an engineer.

"But supposing that you are an engineer, and a good one, which is, after all, the only assumption that we can proceed upon, can you not see that it will be distinctly to your advantage to have all of the other good engineers in the community know what you

can do and how well you can do it, as well as to know some of the things that you have done in the past?

### BE A GOOD MIXER

"Perhaps you are employed now, and are satisfied with the surroundings and salary, and that there is no prospect of a change. Hundreds of others have been in the same circumstances one day, and the next have been left high and dry, through no fault of their own, with no job, and no knowledge of how to get one. Wouldn't their chance of immediate re-employment have been increased greatly if they had been widely and favorably known among the engineers of their town?

"Possibly. But how could they or you achieve such a result without too great a cost?

"By joining a local engineering society, and by attending the meetings and when there by 'mixing.' Make it a point to meet one or two or a dozen new engineers every month. Find out what they have done and are doing and hope to do, and don't be too modest. Let them know who you are and what part of the world your work supports.

"Search out the chairman of the program committee and drop a hint that you have some interesting lantern slides showing a work upon which you were engaged before coming here and if properly pressed will consent to show them to the society and explain the peculiarities of the work.

### CONTRIBUTE TO LECTURES AND PUBLICATIONS

"Look up the publication committee chairman and tell him that you have written, or will be glad to write, a description of some of your experiences in China or Nebraska, as the case may be, if he can use such matter to advantage—which you bet he can.

"When a subject is up for discussion upon which you are informed or wish information, tell what you know, or ask such questions as will bring out the information you seek. Others will thank you, and will form a favorable opinion of your professional skill.

"And if you are in private practice, supplement these methods with a card in the society's year book and another in its journal. This will keep your name before those who can do you the most good."

## Experiments with Concrete for Road Resurfacing

In Wayne County, Michigan, 3-Inch Reinforced Surface Was Laid on Six-Year-Old Pavement After Sprinkling with Hot Tar

THE POSSIBILITY of using concrete as a resurfacing material, if for any reason it is necessary to bring an old concrete road back to a condition equal to new, is being experimented with in Wayne County, Michigan. Edward N. Hines, chairman of the Board of County Road Commissioners, presented a paper at the general meeting of the Portland Cement Association Sept. 13, at Detroit, in which he outlined the experiment he is trying out. The following notes are taken from the paper and from the discussion which followed its reading.

### EXPERIMENT ON GRAND RIVER ROAD

Wayne County has a large and constantly growing mileage of concrete roads. Some day in the far distant future it may be necessary to resurface some of them, and to determine the suitability of concrete for

this purpose a section of the Grand River Road built in 1910 has been made the subject of a resurfacing experiment. This stretch was chosen because of the heavy mixed traffic using the highway. Therefore a severe test would be exacted of the resurfacing, tending to prove or disprove its value.

Grand River Road, where this experiment is being carried on, was built of two-course construction, 16 ft. wide and 6½ in. thick. The bottom course was 1:2½:5 and the wearing course, which is 2½ in. thick, was 1:2:3. It was laid in 25-ft. sections, with ¼-in. tar-paper strips cutting entirely through the concrete. The surface was struck off with a template, but owing to the fact that concrete road work in 1910 in Wayne County was in its infancy, workmen and finishers were not as careful then as they are now to secure a true, even surface. This also seemed to mark the stretch of road chosen as ideal for the resurfacing experiment.

### RESURFACING

Territory served by the Grand River Road has built up rapidly since the highway was paved, and while attempting the resurfacing it was decided to increase the pavement width to 20 ft., better to accommodate the rapidly increasing traffic. In order to do this the slightly rounded edges of the original pavement which had been finished with a 3-in. radius were broken off and new concrete added to bring the pavement to the required width. A 1:2:4 mixture laid 6 in. deep was placed. Before proceeding with the resurfacing all Tarvia that had been used for maintenance purposes was removed from cracks and holes, which were filled with concrete to make an even surface 20 ft. wide. Where expansion joints were spalled to any extent the old concrete was broken away sufficiently to give a bond for new concrete on both sides of the joint. Expansion felt was then placed and the whole surface brought to an even grade.

When the old pavement had been redressed in this manner, there was applied a 3-in. layer of 1:1½:2½ concrete, in which Marquette (Mich.) traprock graded from ¼ to 1 in. and washed and screened bank sand were used as aggregates. In no place is the resurfacing less than 3 in. thick, reinforced with No. 26 triangular mesh.

### TAR FOR BOND

No attempt was made to bond the top course to the old concrete in the usual way. That is, no rigid bond was attempted. The surface of the old concrete was first sprinkled with water, after which a mixture of Tarvia A and Tarvia X was sprinkled on hot immediately before placing the new wearing surface. Falling on the moistened old concrete, the Tarvia spread in a very thin layer and was immediately chilled, thus forming an even coat over the old surface.

Expansion joints in the resurfacing course were made to coincide exactly with expansion joints in the old pavement. A 3 x 4-in. scantling 20 ft. long was laid over the old joint and the concrete deposited as though no joint were to be made. Afterward the scantling was removed and armor-plates with expansion felt between them, suspended from installing bars, were set in place so that the felt of the new joint exactly met the tar paper of the joint in the old pavement. A Baker automatic finishing machine was used to finish the surface.

Before this work was undertaken experiments had been made to point out the advisability of the procedure that finally prevailed. Small slabs of concrete were made, a coat of Tarvia put on top and another course of concrete deposited. Not only was it found impossible to separate these two layers after the concrete had thoroughly hardened, but a blow on the upper surface sufficient to crack the top course would also crack the bottom one.

The usual protective measures were taken to prevent the concrete from drying out, and it was sprinkled daily for two weeks. Traffic was permitted to use the road after twenty-five days.

Mr. Hines made it plain that the work should be regarded purely as an experiment and its results awaited before any general plans are made for its use.

## Omaha Coagulant Plant Uses Improved Alum Process

Manufacture of Aluminum and Iron Sulphate Combined — Heat from Lime Slakers Transferred to Alum Solution

IN the new coagulant house of the Metropolitan Water District of Omaha aluminum sulphate cake is made from bauxite and sulphuric acid. A hot normal solution of the aluminum sulphate is passed over scrap iron on its way to the water to be treated, thereby making it a basic aluminum ferrous sulphate. Lime is used to complete the reaction, and the heat liberated in its slaking is transferred to the alum solution, raising the latter to about 100 deg. Fahr.

Experiments on a large scale had been carried out on this method to determine the controlling factors and to ascertain the sizes necessary before the present plant was designed. These experiments were concluded about the time the alum-making plant at Columbus, Ohio, proved to be successful and construction was held up until this new feature could be added. The war broke at about this time and skyrocketed chemical costs to such an extent that the alum-making plant was all the more a desirable addition, and it was felt that the whole process might as well be undertaken. At present even the making of sulphuric acid is under consideration.

The alum plant is essentially similar to the one at Columbus, but much simplified

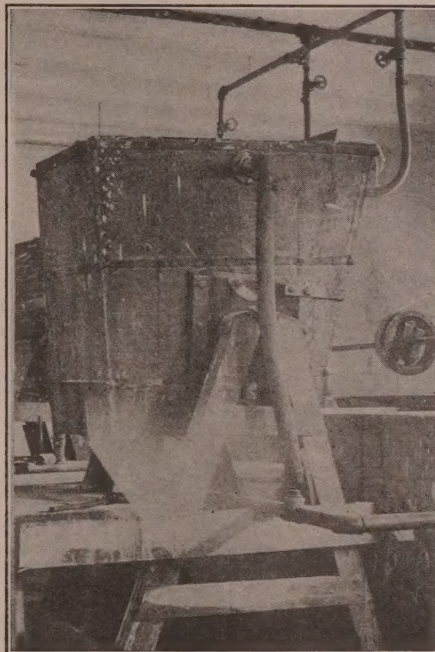


MUSLIN BAGS COLLECT DUST OF PULVERIZED BAUXITE

because no steam is added. The acid reacting on the bauxite forms enough heat and the quantities are apportioned accurately by weighing into a steel tank having a capacity of about 2000 lb. The materials are agitated with steel stirring paddles, motor-driven, for 5 minutes. A 6-in. plug in the bottom is then raised and the liquor flows into a 13 x 25-ft. concrete tank 3 ft. deep. The reaction will be completed on this floor, no evaporation being necessary, as the right amount of water for crystallization is condensed in the 53-deg. Baumé acid used.

The acid (60 deg. Baumé) is bought by the carload and stored in a 10,000-gal. tank to the north of the building. It is unloaded by compressed air through a 1½-in. lead pipe to a 1000-gal. diluting tank, from which it flows by gravity to the acid-weighing tank on a suspended scale over the reaction tank.

The bauxite is purchased from the American Bauxite Company, Bauxite, Salem



LIME-SLAKING TANKS ARE JACKETED TO CONSERVE HEAT

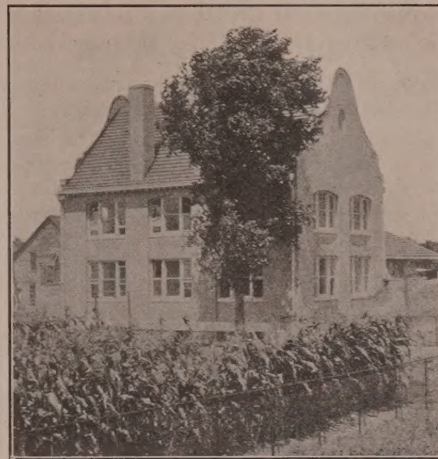
County, Ark., at \$8 per ton. The freight brings the cost at Omaha to \$12 per ton.

At the plant the bauxite is put through a Ramond pulverizer and ejected by a blower into a cyclone collector on the floor above. The surplus air from the cyclone passes into a series of muslin bags, the lower ends of which open into a large cone, thus allowing the air to escape and the fine dust to be recovered.

### SLAKING HEAT UTILIZED

Aluminum sulphate in a normal solution (12 per cent) feeds through the jackets of the lime slakers. The latter are steel tanks, lead lined, on trunnions surrounded by a wooden tank, making a tight compartment for the alum about 4 in. in thickness, sides and bottom. The top is open and the trunnions permit dumping into circular concrete mixing tanks for making milk of lime. The alum lines to and from the interspace are rubber hose to give the necessary flexibility.

A simple wooden tank, 8 x 12 ft. in plan by 2 ft. deep, has six compartments made by under-and-over baffles. The solution remains in the iron vat about 120 minutes and takes up the equivalent of 100 lb.



CHEMICAL PLANT HOUSE WAS DESIGNED FOR ARCHITECTURAL APPEARANCE

or iron per day when the water treated is 20,000,000 gal. daily, with 1.5 gr. per gallon. The feed is regulated through an orifice box with a glass ballcock, the jet dropping into a funnel and being sucked into a 1½-in. pipe 10 ft. above the floor by a water ejector which discharges into the supply under a total head of 15 ft. The murky lime is taken from the mixers in the same way by an ejector. Various points of entry for cleaning out scale are provided and a long run of rubber hose is used instead of iron pipe.

The water for treatment has already had a sedimentation period of 12 hours in three basins not baffled, but very carefully provided at inlet and outlet with weirs for distribution over the end cross-section. Coagulant and lime are added simultaneously into a mixing flume, 5 ft. wide and 10 ft. deep, with baffles spaced 15 ft. apart for 240 ft. along this flume. Following this thorough mixing the water enters the basins for a further period of 24 to 30 hours and a skimming at the outlet of each basin, except in the last basin, which has the outlet 15 ft. below the level of the water.

### RESULTS SATISFACTORY

Before the plant was put into operation and for several years with the old plant the turbidity of the water supply of Omaha has been reduced from 5000 to 10,000 down to 1, 2 and rarely 10 parts per 1,000,000. Bacterial counts are rarely more than 50 and B. coli in the effluent are rarely found. Chlorine takes care of the organisms in liquid form since the recent installation of a Wallace & Tiernan outfit. Previous to that time for five years a bleach plant with concrete mixing tanks was operated.

The alum-iron process was developed by Andrew Jacobson, chemist in charge of the plant at Florence, working under the direction of George T. Prince, chief engineer for the Omaha Metropolitan Water District, of which R. B. Howell is general manager. H. S. Nixon, assistant engineer, has charge of the construction and execution of the work. Charles P. Hoover, Columbus, Ohio, was the consulting engineer.

### Mineral Output from Alaska Increases

The annual statement of the production of gold, silver and copper in Alaska in 1915 shows that the value of the total mineral output from that section during that year was \$32,854,229. The value for 1914 was \$19,065,666.

## Cameron Septic Patents Expired This Week

Status of Infringement Claims Against Imhoff  
Tanks Discussed in Light of Recent  
Developments

By GEORGE W. FULLER  
Consulting Engineer, New York

*For several months past the Engineering Record has received frequent inquiries, emanating for the most part from cities and towns in the Middle West, as to the status of the Cameron and the Imhoff sewage tank patent claims. Apparently there exists much confusion regarding this question, and threats of litigation on the part of the Cameron company have led many engineers to ask about the validity of its claims. The fact that the Cameron patents expired this week (Oct. 3, 1916) makes George W. Fuller's statement a timely one.—EDITOR.*

THE Cameron and Imhoff patents relating to single-story and two-story septic tanks respectively for the treatment of sewage have been discussed at length for a number of years. The patent issued in the United States to Cameron and associates covered both apparatus and process claims, but the Circuit Court of Appeals, Second Circuit, in the Saratoga (N. Y.) case decided that while the Cameron process claims were valid, the apparatus claims were invalid (see Engineering Record, Jan. 25, 1908, page 99).

The principal Imhoff patent refers to apparatus whereby a two-story settling or septic tank is so arranged as to prevent the gases and rising particles in the lower or sludge-digestion chamber from disturbing the contents in the upper or settling compartment.

### BRITISH PATENT DATED 1895

An apparatus patent was issued in England to Cameron in November, 1895, for the regular 14-year life of British patents. Based on the procedure then in vogue in the United States, a patent of British origin would continue in effect in this country only throughout the period when it would be effective in the country of its origin. On this basis the Cameron patents expired in November, 1909, both in England and in the United States.

The International Treaty of Brussels in 1902, to which the United States subscribed, adopted, among other things, a ruling that patents of foreign origin were to have the same life as patents of domestic origin. The Cameron patent, containing both apparatus and process claims in the United States, was issued on Oct. 3, 1899, which, excluding the significance of its foreign origin, would normally give it a life of 17 years, or until Oct. 3, 1916.

Whether the Brussels treaty was so adopted by the United States in such form as to make its patent provisions retroactive or not is a question upon which decisions have varied in different district courts of the United States.

In the Knoxville, Iowa, case it was arranged by counsel that the question of the life of the Cameron patent in the United States should be taken before the United States Supreme Court under certain stipu-

lations as to the identity between the British and United States patents. The decision in this Knoxville case, which went against the Cameron patent, did not exploit the difference between the process claims of the United States patent issued to Cameron and the apparatus claims constituting his earlier English patent, and which apparatus claims, more or less modified, were declared, in the Saratoga decision, to be invalid.

In 1915 the United States District Court held in the Winchester, Ky., case that the Cameron British patents for apparatus did not affect the continuance of the life of the valid process claims of the Cameron United States patent. This virtually ruled that the Cameron septic process claims continued to live until Oct. 3, 1916.

Obviously, a license to use the Imhoff apparatus has no bearing upon the infringement of the Cameron process patent by the Imhoff tank.

Whether or not the Cameron process claims are infringed by two-story septic tanks of the Imhoff type has never come up for adjudication. Opinions have been expressed for and against the infringement by those more or less familiar in a technical and legal way with such matters. The most that can be said at present is that it is an open question.

Since the Winchester, Ky., decision in September, 1915, this question of infringement of the Cameron patent by Imhoff tanks has been made the basis of a number of written demands by the Cameron company for settlement of alleged infringement by operators of Imhoff tanks. But such demands have been met with a counter movement by the National Septic Process Protective League (see Engineering Record, March 25, 1916, page 433).

So far as now known no suits have been instituted against the operators of Imhoff tanks for infringement of the process claims of the Cameron patent. In the event that no suits were so instituted on or before Oct. 3, 1916, then it is our understanding that no suit in equity with prayer to enjoin the use of Imhoff tanks can later be commenced. But without attempting to exploit the legal phases of the matter, it is our understanding that a suit at law to recover damages from those who, prior to the expiration of the Cameron patent, made use of septic tanks of either the one or two-story type, may be brought subsequent to that date, but within the period prescribed by the statute of limitations.

[In answer to an inquiry regarding future litigation of patent claims, the Engineering Record has received from the Cameron Septic Tank Company of Chicago the following telegram:

"Answering your wire, the expiring of Cameron Patent 634423, Oct. 3, does not end either litigation or claims for infringing use of septic process in either Imhoff or any other form of septic tank prior hereto, because statute of limitations for recovery of royalties and other patent damages does not run out for six years, or until Oct. 3, 1922. In fact, only last week we sued Shelbyville, Ky., both under the patent and for connivance with the so-called National Septic Process Protective League, which has headquarters at Marshalltown, Iowa, and was recently organized to obstruct the collection of our established license fees for the use of the septic process."—EDITOR.]

## Railroads Made Big Gain in Year Ended June 30

Report of Bureau of Railway Economics Shows  
41.7 Per Cent Increase in Operating  
Income

GROSS operating revenues for the fiscal year ended June 30 on the large steam railroads of the United States have just been reported by the Bureau of Railway Economics. They totaled \$3,396,808,234, or \$14,818 per mile of line, as against \$12,678 per mile for the previous year, showing an increase of 16.9 per cent. Operating expenses were \$2,220,004,233, or \$9,684 per mile, as against \$8,915 for 1914-15, an increase of 8.6 per cent. Net operating revenue, therefore, was \$1,176,804,001, or \$5,134 per mile, as against \$3,763—an increase of 36.4 per cent; and operating income was \$1,029,241,804, or \$4,490 per mile, as compared with \$3,169 for the previous year—an increase of 41.7 per cent. Taxes were \$146,754,477 or \$640 per mile—an increase over those of 1914-15 of 8.4 per cent.

### EARNINGS BY DISTRICTS

Considering the three districts, the most marked gains were in the Eastern and Southern districts, where the operating incomes per mile increased 52.4 and 51.2 per cent respectively. The gain in the Western district was only 29.5 per cent. In the Eastern district total operating revenues increased 20.3 per cent, attaining the figure of \$26,239 per mile. Operating expenses also increased 10.8 per cent. Operating income was \$7,753 per mile. In the Southern district the total revenues of \$11,611 per mile represented a gain of 15.5 per cent. Operating expenses increased only 4.8 per cent, consequently the operating income of \$3,428 per mile showed the gain of 51.2 per cent already mentioned. In the Western district the \$10,615 per mile total revenue was 14.0 per cent more than in the preceding year, but operating expenses also went up 7.9 per cent. Operating income was \$3,337 per mile. In each district the freight increases in total revenue in per cent were considerably greater than the total increase, while the corresponding percentages of increase for passenger and mail business were small. The Southern and Western districts suffered 10-per cent increases in taxes, as against 5.6 per cent for the Eastern district.

### JUNE RETURNS

For the month of June for the whole country the percentages of increase were respectively 19.0, 16.2, 24.6 and 25.9 for total operating revenues, operating expenses, net operating revenue and operating income. The gains in total revenues were about the same in per cent for all districts; but an increase of 20.9 per cent in operating expenses for the Eastern district as against only 6.4 per cent for the Southern is reflected in an increase of 18.6 per cent operating income for the Eastern as against 55.3 per cent for the Southern. In the latter district, however, the operating ratio was 72.4 in June, 1915, while in the former it was only 66.0, and in June, 1916, the ratios were respectively 65.1 and 66.6.

For the fiscal year for the entire country the operating ratio was 70.3 in 1914-15 and 65.4 to 1915-16. For the year 1913-14 this ratio was 72.7.

# Low-Lift Pumping Plant Uses Distillate Fuel

Two Pumping Units Have, Each, a Capacity of Fifty-Nine Cubic Feet per Second at Two-Foot Lift—Plant Drains Land Near New Orleans

By B. S. NELSON

Engineer and Construction Superintendent for A. M. Lockett & Company

THE DRAINING of the wet lands of southern Louisiana has attracted the attention of landowners and capitalists, as it has proved practicable to drain land that has long been thought useless for any purpose, and valued at \$2 or \$3 to \$10 per acre. By a moderate expenditure in a drainage plant and canal system areas are converted into rich farmlands worth from \$100 to \$300 per acre. There are several millions of acres of such land in Louisiana, and the past drainage work is only a small part of what will be done in the near future.

As is usual in any new development, there has been considerable diversity of opinion among engineers as to the type of pumping plant best suited to drainage work. A number of engineers, seeing the possibilities in the drainage field, have specialized in this work and made careful studies of the pumping-plant problems. This has led to the compiling of rainfall and runoff data which, to a certain extent, has standardized the needed capacity per acre and the lift. No one type of prime mover is favored, but the tendency is all toward some form of internal-combustion engine. The centrifugal pump is universally used, as it is adapted to moving large volumes of water at low lifts. Most of the pumping is done at 4 to 5-ft. lifts.

## DISTRICT COMPRISES 1700 ACRES

The Fourth Jefferson Drainage District, in the parish of Jefferson, adjacent to the city of New Orleans, comprises about 1700 acres. The territory starts near Lake Pontchartrain and extends back about 3 miles along the Seventeenth Street canal, which is one of the main outfalls of the New Orleans drainage system. The Jefferson plant—the general arrangement of which is shown—discharges into this outfall canal and thence to Lake Pontchartrain, which is practically an arm of the Gulf of Mexico. This installation is a good example of what is being done in this line.

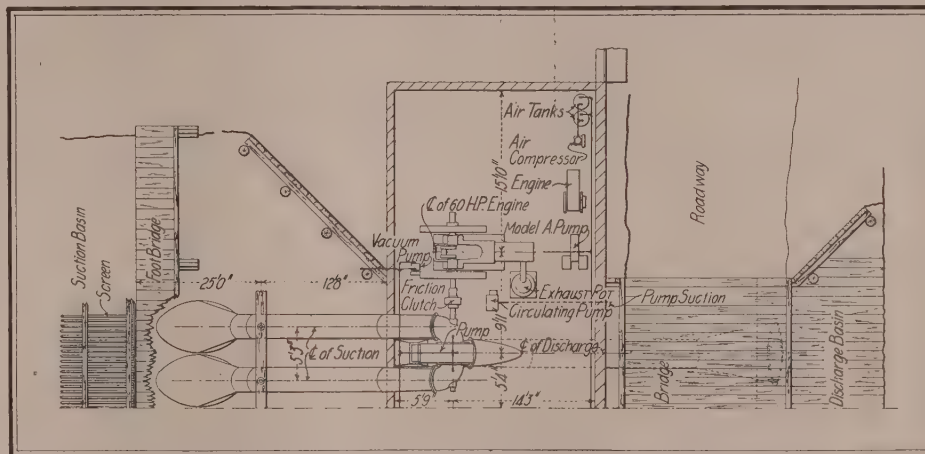
The pumping equipment consists of two duplicate units, each with a capacity of 59 cu. ft. per second at 2-ft. lift and capable of pumping at any head between zero and 10 ft.—the capacity decreasing as the head

increases. The pumps are of the Worthington 30-in. double-suction slow-speed drainage class with special radial and axial-flow type of impellers having a nearly constant horsepower input at all heads.

The pumps are direct-connected through friction-clutch couplings to 60-hp. 190 r.p.m. Ingeco distillate engines designed to operate on cheap distillate of 39 Baumé gravity costing about 4 cents per gallon delivered at the plant. The engines are started on gasoline, run for a few minutes

belting off the hub of the clutch coupling, one to each unit. Each of these pumps is of ample size to supply water to both main engines and to the water-sealed glands of the main pumps. To insure a supply of water in starting and if anything should go wrong with the circulating pumps, a 500-gal. elevated tank was erected. This furnishes an hour's supply for one engine, and is so piped that should the pump stop working water would still flow to the jackets. An added advantage of this arrangement is that it gives a constant head of water on the jackets at all times.

Other auxiliaries in the plant consist of a 3½ x 3½-in. air-cooled air compressor belted to a 2½-hp. kerosene engine for the air-starting system. The compressor delivers to two 1½ x 6-ft. brazed-steel air tanks which, when charged to 90-lb. pres-



PLAN OF SIDE OF PLANT CONTAINING AIR-COMPRESSING EQUIPMENT

until the jackets warm up, and then switched to distillate by throwing the handle of a six-way cock.

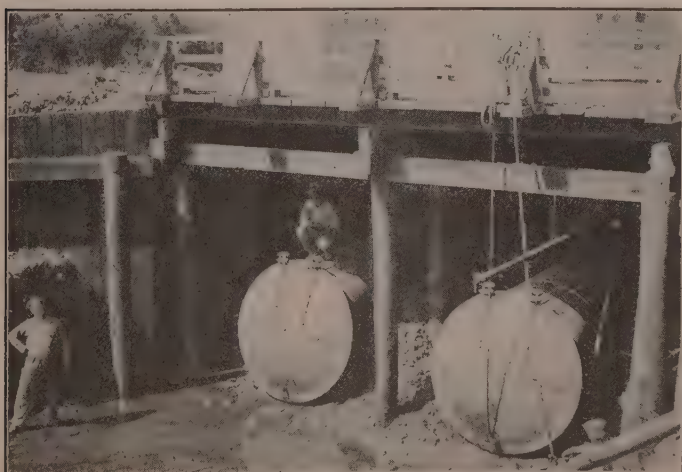
Batteries are unnecessary, as the engines are fitted with oscillating magnetos suitable for starting as well as running—a valuable feature for an isolated plant.

Each pump is primed by means of a rotary vacuum pump driven through a friction drive from the flywheel of the main engine. These pumps are cross-connected so that either main unit can be primed from either vacuum pump. The vacuum-pump suctions are connected to the top of the main pump casing and also to both suction elbows, so that the pumps may be primed either before or after the clutch is thrown in.

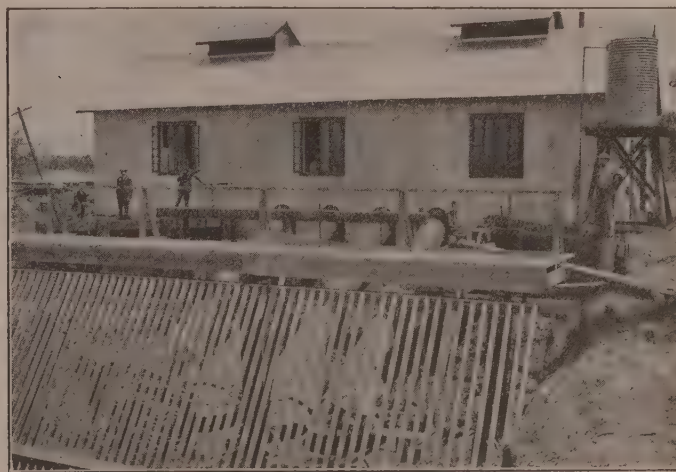
Water is supplied by two rotary pumps

sure, give air for several starts of the main engine. The engines are started by a hand-operated lever admitting air on the explosion stroke. The auxiliary engine is also belted to a 4 x 5-in. Deane single-cylinder double-acting power pump used for transferring fuel oil from a barge in the outfall canal to the main storage tank.

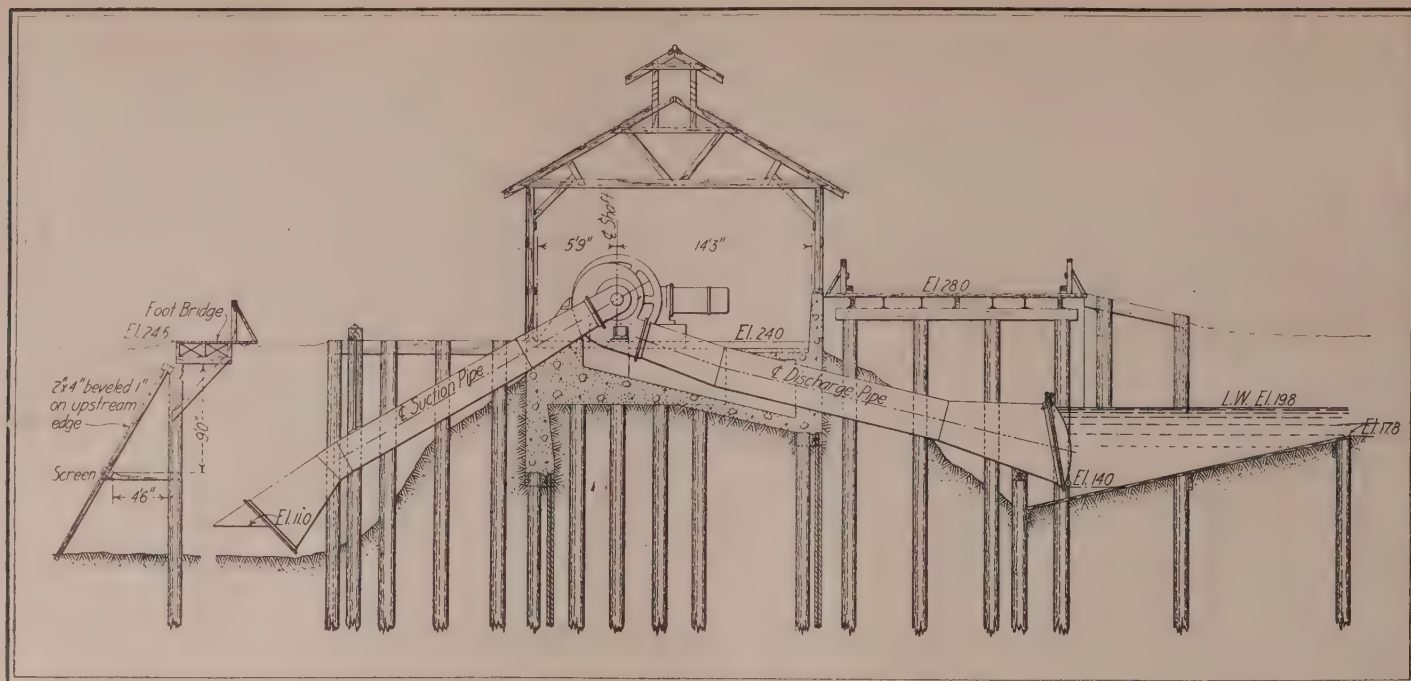
This storage tank is a 3310-gal. vertical galvanized corrugated iron tank set 100 ft. away from the building and elevated about 1 ft. from the ground. There are two 125-gal. auxiliary fuel tanks buried under the ground just outside the building. One of these is for distillate and the other for gasoline. A small fuel pump on the engine takes oil from either of these tanks and pumps it to the vaporizer, where the surplus oil overflows back to the tank.



OUTFALL CANAL PAVED WITH WOODEN APRON 2 INCHES THICK



SCREEN CATCHES GRASS AND TRASH OTHERWISE DRAWN INTO PUMPS



WEIGHT OF FOUNDATIONS AND MACHINERY CARRIED ON 40-FOOT ROUND PILES—FOOT BRIDGE BUILT ON TOP OF SCREEN

The suction and discharge pipes on the main pumps are shown on the drawings. These pipes are of  $\frac{1}{4}$ -in. riveted steel, of such size and design as to reduce the loss of head to about 0.5 ft. This is done by making the cross-section of the straight pipe such as to reduce the velocity to a point where the friction loss is only 0.25 ft., and using long taper increasers and liberal bell mouths to reduce the loss due to velocity head. These calculations were made for the capacity at a normal working head of 4 to 5 ft.

Flap valves are used on the discharge pipes, not for the usual purpose of priming the pumps, but to prevent water running back into the district in the event of an unusually high tide in Lake Pontchartrain.

The plant is practically a narrow dam across the canal set just back of the outside levee—the usual arrangement of drainage plants in this territory. Seepage is prevented by a double line of Martinez piling 24 ft. long. One line of piles at the front of the plant extends 45 ft. on either side of the center of the canal; the other is on the suction side, and only as long as the building. There are also short sheet-pile wing walls on the suction and discharge sides of the plant. The outfall canal is paved with a wooden apron 2 in. thick, extending about 20 ft. in front of the ends of the discharge pipe.

The weight of the foundations and machinery is carried on 40-ft. round piles, each carrying a load of 8 tons. All piling that extend above the water line are creosoted. All foundations are of 1:3:5 concrete made with washed gravel. The retaining walls on the suction and discharge sides of the plant extend below the water line and are reinforced with square twisted bars.

The pump and engine foundations are monolithic, tied to each other and to the front and rear walls by reinforcement. The floor slab is reinforced to allow the setting of the heaviest part of the machinery on it. The top 4 in. of the floor is ordinary cement pavement.

The building is of wood-frame construction covered with corrugated galvanized

iron. Ample lighting is provided by plenty of windows and by painting all interior woodwork white.

As the levee in which the plant is built is also a road, a bridge of 24-ft. span had to be provided over the outfall canal with a 16-ft. roadway. In the suction basin, about 50 ft. back of the plant, a screen was built to keep trash out of the pump.

The plant was designed and installed by A. M. Lockett & Company, Limited, of New Orleans. The specifications were prepared by A. M. Shaw, consulting engineer for the drainage district, and the construction work and working details were supervised by the author.

## Plans Proposed for Boston Fire-Service System

Insurance Interests Do Not Look with Favor on Project for Small-Capacity Pumping Station

**S**UBSTANTIAL changes in the design of the Boston high-pressure fire-service system have been recommended in a report submitted to Mayor Curley by Joseph Rourke, engineer in charge of the work. Mr. Rourke advocates a smaller pumping station than had been originally planned and the increased use of fire engines. Comment by representatives of the insurance interests at Boston is unfavorable to the proposed economies of the Rourke report. The underwriters will probably refuse to remove the advance in fire-insurance rates which was placed upon buildings and their contents within the Boston conflagration area at the time of the San Francisco fire unless the high-pressure pumping station is built so that the original 24,000 gal. per minute can be attained. F. E. Cabot, secretary of the Boston Board of Fire Underwriters, is quoted as saying: "If the Rourke plan were followed out and Boston had a conflagration, the city's fire-fighting forces would be in the same predicament as the United States Army if we went to war to-morrow. I am told that we have ammunition enough to last just twenty-five minutes if we fired all our big guns at a foe. That's

just about what the situation would be for the Boston fire fighters, substituting water for powder and shells." Through the courtesy of Edward F. Murphy, commissioner of public works, the following summary of Mr. Rourke's report is given:

### PREVIOUS PLANS

Previous designs for the pumping installation for high-pressure fire service have been based upon a capacity of 18,000 gal. per minute at 300 lb. delivery pressure, with provision for the future addition of 6000 gal. per minute. A plant of this size requires considerable land, and discussion of various sites finally led to the favorable consideration of a site in the Charles River Basin, off the Charles bank. In 1911 a reduction in insurance rates equal to 15 per cent added at the time of the San Francisco fire was promised by the Boston Board of Fire Underwriters upon completion of a high-pressure system satisfactory to that body. At the time this totaled from \$100,000 to \$125,000 a year. No fire engines at present in the high value district can be permanently transferred elsewhere. A million dollars was originally considered enough to spend in this special protection, which now offers little financial return to the city. Mr. Rourke holds that this outlay should not be exceeded when there is little or no return in prospect upon it.

Investment in the streets now totals \$457,000, including all expenses since the organization of the service, and there is \$162,000 worth of pipe-line materials now on hand ready to install. The cash assets are about \$319,000. To complete the system of 14.35 miles of gridiron as originally planned with a large station in the Basin will require a total of about \$1,500,000, and with large yearly fixed charges due to the station alone.

A decided tendency has recently been shown from the legislative standpoint toward fire-prevention enactments. Due to the powers vested in the Fire Prevention Commissioner in 1914 and in the Building Commissioner of Boston, which are being vigorously utilized, it appears that there may be little need for a high-pressure serv-

ice in the district proposed within ten years, due principally to the remarkable acceleration in the use of sprinkler equipment in the past two years in hazardous-risk buildings within the district and elsewhere.

#### SMALL PUMPING STATION

The efficiency of high-pressure fire service is chiefly due to providing good streams of water at a satisfactory pressure directly from hydrants in the minimum time. Mr. Rourke maintains that reasonable requirements for the Boston high-value district would be fulfilled by a small pumping station of about 6500 gal. per minute capacity at 240 lb. delivery pressure, which is the equivalent of more than twenty good fire streams, or about thirteen ordinary fire engines. At 125 lb. delivery pressure nearly 12,000 gal. can be supplied by this station. All of this may be available within five minutes of the alarm, and 2000 gal. can be secured within 1.5 min., which will always anticipate its application to the fire. Additional supply, if desired, can be furnished by fire engines drawing water from the ordinary distribution systems and pumping direct into high-pressure hydrants, and by fireboats in extreme emergency. Portable fire engines, in the opinion of Mr. Rourke, possess the added advantage of being able to respond to fires in any location, besides furnishing a reserve for the high-pressure area, while the reserve capacity of a large pumping station is available only for its hydrant service in a limited area. It is recommended that if a 6500-gal. station is decided upon, it be located on the Charles River embankment. Another possible location adjoins the park in the North End, where there are at present a fireboat and crew quarters.

#### ELECTRIC POWER FOR HIGH-PRESSURE STATION

Regarding electric power for the high-pressure station, Mr. Rourke states that negotiations with the Boston Edison company have not been entirely satisfactory and that these imply considerable annual fixed charges which would be absent were a gas-engine centrifugal pumping plant adopted. Advantages accrue to the presence of gas in storage, and the only question arises as to the speed with which a unit could be put in commission. Electrically driven pumps are admittedly faster, but the small difference in time is unimportant, as the demand for water at the fire may easily be anticipated with either gas or electric service. It is figured that with the small gas engine plant the money now available and materials on hand will enable the installation of a gridiron pipe system of 11.5 miles with hydrant service, whereas with the large pumping station and present appropriation, only 6.5 miles (the present system) with one feeder could be provided.

#### White Bridges Mark Auto Trail

White-lead paint is now being applied to all the bridges in Richardson County, Nebraska, on the Omaha-Kansas City trail. The county commissioners are doing this to mark the road properly, to make it impossible for automobile drivers to miss an approach at night and at the same time to protect the structures from weather. In the case of concrete culverts, only the iron handrails are painted. It is expected that the other counties along this route will also adopt this scheme.

## Distribution of Traffic on a Rectangular System of Roads Analyzed

In Any Large Area 15 or 20 Per Cent of Roads Carry 80 or 85 Per Cent of Traffic, and Expenditures Should Be Governed Accordingly

By E. W. JAMES

Chief of Maintenance, Office of Public Roads and Rural Engineering, Washington, D. C.

THE QUESTION of the distribution of traffic over a system of roads is significant in that its solution will, to a large degree, determine the relative importance of various roads and furnish an essential factor in determining the total mileage that it is economical to improve. The indeterminate conditions to be considered in such a problem are many, and the only practicable method of arriving at a general solution is deductive. We can then test our result by comparing it with actual observed or recorded instances.

To give the matter definite form, we will make the following general assumptions: (1) The roads are laid out in a township according to the theoretical system in use on public lands of the United States, and the main market point is at the center. (2) The discussion uses the quarter section of

symmetrically divided and symmetrically located around the central point of the township.

Table 1 shows the amount of traffic originating in each quarter section and passing over the roads lying in the area considered, and also shows the traffic produced on each mile of road. The roads are indicated by naming the sections lying on each side of each mile using  $x$  for all area outside the township.

Let  $T$  be the amount of traffic produced on 1 mile of road by the uniform conditions existing in each quarter section. Then, in the area considered,  $T/2$  traffic is produced by each half of a quarter section in such area. The traffic on each road is, therefore, found by multiplying the traffic produced on 1 mile by the fraction of a mile traversed. For instance, the half of the quarter section NE-1 produces  $T/2$  traffic on 1 mile, and therefore produces  $T/2 \times \frac{3}{4}$ , or  $\frac{3}{8}T$  traffic on the road 1- $x$ , since the traffic enters the mile of road 1- $x$  at the middle point of the quarter section NE-1 and traverses  $\frac{3}{4}$  of a mile on this piece of road.

From this table we find the total traffic passing over the roads of the area is  $53.23T$ , and the total traffic for the whole township would be  $426T$ .

#### TRAFFIC ON TYPE ROADS

Passing now to Table 2, we can tabulate the roads representing a symmetrical group, the traffic passing over each group, the length of each group and the various percentages of the total road mileage that carry various percentages of the total traffic. Each section of road in the area considered has its counterpart in every other such area. Therefore, each such mile is typical of a group composed of 4 or 8 miles, according to the location of the particular type road, whether it is or is not common to two of the symmetrical areas. Thus road 15-22, being common to the triangular areas above and below the east road, is typical of a group of four, and road 14-13, lying wholly within the area under consideration, is typical of a group of eight. We find, for instance, that 4 miles of road, or 4.8 per cent of the total, carry 32.6 per cent of all the traffic; that 14.3 per cent of the roads carry 68.3 per cent of the traffic; that 23.8 per cent of the roads carry 78.6 per cent of the traffic, etc. By interpolating, 25 per cent of the roads carry about 80 per cent of the traffic.

#### DEVELOPMENT NOT UNIFORM

One of the special assumptions made in this case is to the effect that development is equal over all areas under consideration. Obviously this assumption presupposes conditions altogether too uniform and regular. Observation discloses that development and production are not uniform for all areas. Population and development are both in the nature of accretions to a central nucleus. The census records, traffic censuses as taken on highways, all our general observations, indicate harmoniously that development is greatest near a center of population.

|    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|
| 6  | 5  | 4  | 3  | 2  | NW | NE |
|    |    |    |    |    | SW | SE |
| 7  | 8  | 9  | 10 | 11 |    | 12 |
| 18 | 17 | 16 | 15 | 14 |    | 13 |
| 19 | 20 | 21 | 22 | 23 |    | 24 |
| 30 | 29 | 28 | 27 | 26 |    | 25 |
| 31 | 32 | 33 | 34 | 35 |    | 36 |

TYPICAL ARRANGEMENT OF TOWNSHIP ROADS

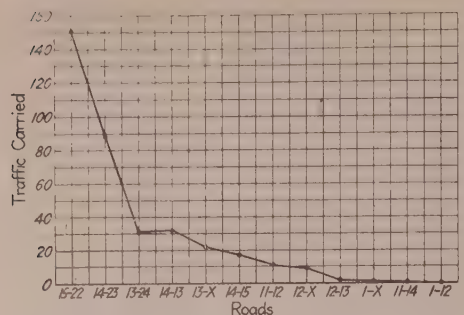
land as the unit. (3) All hauling originating in any quarter section leaves from the middle point on the most advantageous side of the quarter with respect to the haul, and follows the best route to town.

These general assumptions will hold for all cases, but in addition a series of secondary assumptions of great importance must be made to approximate the various conditions under which traffic may originate and use the roads.

#### UNIFORM DEVELOPMENT ASSUMED

In the first case we will assume (1) that all quarter sections, regardless of location, agricultural condition or distance from the town are settled, developed and equally productive, and (2) that there are four cardinal roads improved, extending north, east, south and west from the center to the township lines. The plat of the township shows the rectangular layout of the roads under the general assumption and the four main roads improved, according to the special assumption for this case.

The quarter sections are referred to in the usual way, NW-1, SE-1, etc., and only the area south and east of the dotted line and north of the main east road is considered. There are, then, eight such areas



RELATIVE IMPORTANCE OF TYPE ROADS SHOWN GRAPHICALLY

The degree of irregularity of actual development is not itself constant, nor is it easily determinable for any given locality. We may assume, then, some more or less regular change in uniformity of distribution and adjust the results to accord with actual conditions as our judgment directs.

Instead of a constant production for each area, let us now assume (1) a varied development decreasing inversely as the distance from the center, and retain our former assumption (2) that there are four main improved roads. Using again the common system of land subdivision and calling  $T$ , as before, the amount of traffic produced on 1 mile by a certain production  $P$ , we can tabulate the various quarter sections and calculate the number of  $P$  for each.  $P$  may be considered as a certain constant quantity of traffic-producing produce raised on a quarter section.

Table 3 shows the various typical or symmetrical quarter sections, the distance of their centers from the center of the township, and the number of  $P$  produced by each.

Continuing in Table 4 as in Table 1, we find the traffic on each mile of road. Then in Table 5 we show the various percentages of road mileage that carry various percentages of traffic.

From this table we find that 4 miles of road, or 4.8 per cent of the total mileage, carry 39.3 per cent of the total traffic, that 9.5 per cent of the roads carry 63 per cent

of the traffic, and that 14.3 per cent of the roads carry 71 per cent of the traffic.

As a third case we can change assumption (1), that measures distances in straight lines between the center of the township and the center of each quarter section, to the assumption that the effective distance of the quarter section from the center is the distance that the farmer actually travels along the road from his quarter section to the town.

We could continue this system of investigation by assuming a different set of improved roads. For instance, the four main improved roads could be assumed to extend northeast, southeast, southwest and northwest, and we should get a new set of percentages. It appears that the percentage of traffic as compared with the percentage of roads would tend to increase slightly as our assumptions approached actual conditions. The increases would, however, be smaller and smaller.

As the system becomes more and more irregular by the introduction of half and quarter section-line roads, the total mileage increases, and the main roads near town, toward which traffic converges in all cases, become a smaller and smaller percentage of the road mileage. Similarly, as the road system becomes more and more radial, the total mileage is increased and consequently the percentage of miles represented by the trunk roads near town becomes smaller. For such irregularities tend to be introduced near the limits of the area rather than near town; otherwise the area would lose its rural and assume suburban or urban characteristics, in which case it would no longer be within the scope of this discussion. Thus we have a continual tendency as irregularities are introduced for a smaller and smaller percentage of the road system to carry any given percentage of traffic.

#### A FEW ROADS CARRY MOST OF TRAFFIC

The limits cannot, of course, be definitely set, and almost certainly would not be the same in any two cases; but various estimates made by engineers as the results of

TABLE 3—PRODUCTION OF VARIOUS QUARTER SECTIONS, AND DISTANCES FROM CENTER OF TOWNSHIP

| Typical quarter sections, symmetrically located | Distances from quarter section to center of township, miles | Direct proportions of distances | Number of $P$ produced by each quarter section |
|-------------------------------------------------|-------------------------------------------------------------|---------------------------------|------------------------------------------------|
| SW-15                                           | 0.35                                                        | 1                               | 100                                            |
| SE-15                                           | 0.79                                                        | 2.29                            | 44                                             |
| NE-15                                           | 1.05                                                        | 3                               | 33                                             |
| SW-14                                           | 1.27                                                        | 3.63                            | 28                                             |
| SE-14                                           | 1.46                                                        | 4.17                            | 24                                             |
| NE-14                                           | 1.75                                                        | 5                               | 20                                             |
| NW-14                                           | 1.76                                                        | 5.03                            | 20                                             |
| SW-11                                           | 1.90                                                        | 5.43                            | 18                                             |
| SE-11                                           | 2.15                                                        | 6.14                            | 16                                             |
| NE-11                                           | 2.45                                                        | 7                               | 15                                             |
| SW-13                                           | 2.28                                                        | 6.46                            | 15                                             |
| SE-13                                           | 2.37                                                        | 6.49                            | 15                                             |
| NE-13                                           | 2.57                                                        | 7.34                            | 13                                             |
| NW-13                                           | 2.85                                                        | 8.14                            | 12                                             |
| SW-12                                           | 3.15                                                        | 9                               | 11                                             |
| SE-12                                           | 2.76                                                        | 7.89                            | 13                                             |
| NE-12                                           | 2.85                                                        | 8.14                            | 12                                             |
| NW-12                                           | 3.02                                                        | 8.63                            | 12                                             |
| SW-1                                            | 3.26                                                        | 9.31                            | 11                                             |
| SE-1                                            | 3.55                                                        | 10.14                           | 10                                             |
| NE-1                                            | 3.85                                                        | 11                              | 9                                              |

actual observations are to the effect that 80 or 85 per cent of all the traffic in any large area, such as a county or state, is carried on 15 or 20 per cent of the roads. Pennsylvania has adopted a system of state roads approximating 10 per cent of the total mileage, and has done so with the intent of having all main roads in the system; New Jersey has had the same percentage recommended by its commissioner.

Referring now to the original statement of the question, we can draw some interesting conclusions from the tabular computations shown above.

With respect to the relative importance of various roads, for instance, we find under the first case, where  $T$  is assumed equal for all quarter sections, that road 14-13 carries as heavy a traffic as 13-24, and should of course be the first spur road built. Road 13-24 is selected, however, as a part of the system because it is one of a group of four symmetrical roads, whereas 13-14 is one of a group of eight, and because the omission of 13-24 in one township and its abutting road, 18-19, in another

TABLE 1—TRAFFIC ON EACH ROAD IN ONE-EIGHTH OF TOWNSHIP AREA UNDER UNIFORM DEVELOPMENT

| Quarter section | Traffic produced (T) | Route and traffic on each road |       |       |       |       |       |       |       |       |       |       |       |  |  |  |  |
|-----------------|----------------------|--------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|--|--|--|
|                 |                      | 1-x                            | 12-x  | 13-x  | 1-12  | 12-13 | 13-24 | 11-12 | 14-13 | 11-14 | 14-23 | 14-15 | 15-22 |  |  |  |  |
| NE-1            | T/2                  | 0.37                           | 0.50  | 0.50  | ..... | 0.50  | ..... | ..... | 0.50  | ..... | 0.50  | ..... | 0.50  |  |  |  |  |
| SE-1            | T                    | 0.25                           | 1.00  | 1.00  | ..... | 1.00  | ..... | ..... | 1.00  | ..... | 1.00  | ..... | 1.00  |  |  |  |  |
| SW-1            | T/2                  | .....                          | ..... | ..... | 0.12  | ..... | 0.50  | 0.50  | ..... | 0.50  | 0.50  | ..... | 0.50  |  |  |  |  |
| NW-12           | T                    | .....                          | 0.75  | 1.00  | ..... | 1.00  | 0.75  | 1.00  | ..... | 1.00  | 1.00  | ..... | 1.00  |  |  |  |  |
| SE-12           | T                    | .....                          | 1.00  | ..... | 0.25  | 1.00  | ..... | ..... | 1.00  | ..... | 1.00  | ..... | 1.00  |  |  |  |  |
| SW-12           | T                    | .....                          | ..... | ..... | 0.25  | ..... | ..... | 1.00  | ..... | 1.00  | 1.00  | ..... | 1.00  |  |  |  |  |
| NW-13           | T                    | .....                          | ..... | ..... | ..... | ..... | 0.75  | ..... | 1.00  | ..... | 1.00  | ..... | 1.00  |  |  |  |  |
| NE-13           | T                    | .....                          | 0.75  | ..... | ..... | 1.00  | ..... | ..... | 1.00  | ..... | 1.00  | ..... | 1.00  |  |  |  |  |
| SE-13           | T                    | .....                          | ..... | ..... | 0.75  | ..... | ..... | 1.00  | ..... | 1.00  | 1.00  | ..... | 1.00  |  |  |  |  |
| SW-13           | T                    | .....                          | ..... | ..... | 0.25  | ..... | ..... | 1.00  | ..... | 1.00  | 1.00  | ..... | 1.00  |  |  |  |  |
| NE-11           | T/2                  | .....                          | ..... | ..... | ..... | 0.37  | 0.50  | ..... | 0.50  | ..... | 0.50  | ..... | 0.50  |  |  |  |  |
| SE-11           | T                    | .....                          | ..... | ..... | ..... | 0.25  | 1.00  | ..... | 1.00  | ..... | 1.00  | ..... | 1.00  |  |  |  |  |
| SW-11           | T/2                  | .....                          | ..... | ..... | ..... | ..... | ..... | 0.12  | ..... | 0.50  | 0.50  | ..... | 0.50  |  |  |  |  |
| NW-14           | T                    | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 0.12  | ..... | 0.75  | 1.00  | ..... |  |  |  |  |
| NE-14           | T                    | .....                          | ..... | ..... | ..... | ..... | 0.75  | ..... | 1.00  | ..... | 1.00  | ..... | 1.00  |  |  |  |  |
| SE-14           | T                    | .....                          | ..... | ..... | ..... | ..... | ..... | 0.75  | ..... | 1.00  | 1.00  | ..... | 1.00  |  |  |  |  |
| SW-14           | T/2                  | .....                          | ..... | ..... | ..... | ..... | ..... | 0.25  | ..... | 1.00  | 1.00  | ..... | 1.00  |  |  |  |  |
| NE-15           | T/2                  | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 0.37  | 0.50  | ..... | 0.50  | ..... |  |  |  |  |
| SE-15           | T                    | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 0.75  | ..... | ..... | 0.75  | ..... |  |  |  |  |
| SW-15           | T/2                  | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | ..... | 0.12  | ..... | ..... | 0.12  |  |  |  |  |
|                 |                      | 0.62                           | 2.25  | 4.25  | 0.12  | 0.50  | 5.50  | 1.87  | 5.50  | 0.12  | 13.50 | 1.62  | 17.37 |  |  |  |  |

TABLE 2—TRAFFIC AND PERCENTAGES OF TRAFFIC ON TYPE ROADS

| Type road of symmetrical group | Total miles in group | Total miles | Percentage of mileage | Traffic on type road of group | Total traffic on group | Percentage of traffic on group | Percentage of total traffic |
|--------------------------------|----------------------|-------------|-----------------------|-------------------------------|------------------------|--------------------------------|-----------------------------|
| 15-22                          | 4                    | 4           | 4.8                   | 17.37                         | 139                    | 32.6                           | 32.6                        |
| 14-23                          | 4                    | 8           | 9.5                   | 13.50                         | 108                    | 25.4                           | 58.0                        |
| 13-24                          | 4                    | 12          | 14.3                  | 5.50                          | 44                     | 10.3                           | 68.3                        |
| 14-13                          | 8                    | 20          | 23.8                  | 5.50                          | 44                     | 10.3                           | 78.6                        |
| 13-x                           | 8                    | 28          | 32.3                  | 4.25                          | 34                     | 8.0                            | 86.6                        |
| 12-x                           | 8                    | 36          | 42.8                  | 2.25                          | 18                     | 4.2                            | 90.8                        |
| 11-12                          | 8                    | 44          | 52.3                  | 1.87                          | 15                     | 3.5                            | 94.3                        |
| 14-15                          | 8                    | 52          | 61.8                  | 1.62                          | 13                     | 3.1                            | 97.4                        |
| 1-x                            | 8                    | 60          | 71.3                  | 0.62                          | 5                      | 1.2                            | 98.6                        |
| 12-13                          | 8                    | 68          | 80.8                  | 0.50                          | 4                      | 0.9                            | 99.5                        |
| 11-14                          | 8                    | 76          | 90.3                  | 0.12                          | 1                      | 0.2                            | 99.7                        |
| 1-12                           | 8                    | 84          | 100.0                 | 0.12                          | 1                      | 0.2                            | 99.9                        |
|                                |                      |             |                       | 53.23                         | 426                    | 99.9                           |                             |

TABLE 4—TABLE 1 REVISED TO SHOW THE UNEQUAL DEVELOPMENT TO BE EXPECTED

| Quarter section | Produce (P) | Route and traffic on each road |       |       |       |       |       |       |       |       |       |        |       |        |  |  |  |
|-----------------|-------------|--------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|--------|--|--|--|
|                 |             | 1-x                            | 12-x  | 13-x  | 1-12  | 12-13 | 13-24 | 11-12 | 14-13 | 11-14 | 14-23 | 14-15  | 15-22 |        |  |  |  |
| NE-1            | 9           | 3.37                           | 4.50  | 4.50  | ..... | ..... | 4.50  | ..... | ..... | 4.50  | ..... | 4.50   | ..... |        |  |  |  |
| SE-1            | 10          | 2.50                           | 10.00 | 10.00 | ..... | ..... | 10.00 | ..... | ..... | 10.00 | ..... | 10.00  | ..... |        |  |  |  |
| SW-1            | 11          | .....                          | ..... | ..... | 1.37  | ..... | 5.50  | 5.50  | ..... | 5.50  | ..... | 5.50   | ..... |        |  |  |  |
| NW-12           | 12          | .....                          | ..... | ..... | ..... | 11.00 | ..... | 8.00  | 12.00 | ..... | 12.00 | .....  | 12.00 |        |  |  |  |
| NE-12           | 11          | .....                          | 8.25  | 11.00 | ..... | ..... | ..... | ..... | 11.00 | ..... | 12.00 | .....  | 11.00 |        |  |  |  |
| SE-12           | 12          | .....                          | ..... | 12.00 | ..... | 3.00  | 12.00 | ..... | ..... | 12.00 | ..... | 12.00  | ..... |        |  |  |  |
| SW-12           | 13          | .....                          | ..... | ..... | 3.25  | ..... | ..... | 13.00 | ..... | 13.00 | ..... | 13.00  | ..... |        |  |  |  |
| NW-13           | 15          | .....                          | ..... | ..... | ..... | ..... | 11.25 | ..... | 15.00 | ..... | 15.00 | .....  | 15.00 |        |  |  |  |
| NE-13           | 12          | .....                          | 9.00  | ..... | ..... | 12.00 | ..... | ..... | 12.00 | ..... | 12.00 | .....  | 12.00 |        |  |  |  |
| SE-13           | 13          | .....                          | ..... | ..... | 9.75  | ..... | ..... | ..... | 13.00 | ..... | 13.00 | .....  | 13.00 |        |  |  |  |
| SW-13           | 15          | .....                          | ..... | ..... | 3.75  | ..... | ..... | ..... | 15.00 | ..... | 15.00 | .....  | 15.00 |        |  |  |  |
| NE-11           | 15          | .....                          | ..... | ..... | ..... | 5.62  | 7.50  | ..... | 7.50  | ..... | 7.50  | .....  | 7.50  |        |  |  |  |
| SE-11           | 16          | .....                          | ..... | ..... | ..... | 4.00  | 16.00 | ..... | 16.00 | ..... | 16.00 | .....  | 16.00 |        |  |  |  |
| SW-11           | 20          | .....                          | ..... | ..... | ..... | ..... | 2.50  | ..... | 10.00 | 10.00 | ..... | 10.00  | ..... |        |  |  |  |
| NW-14           | 24          | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 18.00 | 18.00 | ..... | 18.00  | ..... |        |  |  |  |
| NE-14           | 18          | .....                          | ..... | ..... | ..... | ..... | 13.50 | ..... | 18.00 | ..... | 18.00 | .....  | 18.00 |        |  |  |  |
| SE-14           | 20          | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 15.00 | ..... | 20.00 | .....  | 20.00 |        |  |  |  |
| SW-14           | 28          | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 7.00  | ..... | 28.00 | .....  | 28.00 |        |  |  |  |
| NE-15           | 33          | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 12.37 | 16.50 | ..... | 16.50  | ..... |        |  |  |  |
| SE-15           | 44          | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 33.00 | ..... | 33.00 | .....  | 33.00 |        |  |  |  |
| SW-15           | 100         | .....                          | ..... | ..... | ..... | ..... | ..... | ..... | 12.50 | ..... | 12.50 | .....  | 12.50 |        |  |  |  |
|                 |             | 451                            | 5.87  | 22.75 | 46.50 | 1.37  | 6.25  | 63.00 | 23.12 | 78.75 | 2.50  | 186.50 | 40.37 | 308.50 |  |  |  |

TABLE 5—TABLE 2 SIMILARLY REVISED TO SHOW UNEQUAL DEVELOPMENT

| Type road of symmetrical group | Total miles in group | Total miles | Percentage of mileage | Traffic on each type road of group | Total traffic on group | Per cent of traffic on group | Percentage of total traffic |
|--------------------------------|----------------------|-------------|-----------------------|------------------------------------|------------------------|------------------------------|-----------------------------|
| 15-22                          | 4                    | 4           | 4.8                   | 308.50                             | 2468.00                | 39.3                         | 39.3                        |
| 14-23                          | 4                    | 8           | 9.5                   | 186.50                             | 1492.00                | 23.7                         | 63.0                        |
| 13-24                          | 4                    | 12          | 14.3                  | 63.00                              | 630.00                 | 8.0                          | 71.0                        |
| 14-13                          | 8                    | 20          | 23.8                  | 78.75                              | 504.00                 | 10.0                         | 81.0                        |
| 13-x                           | 8                    | 28          | 32.3                  | 46.50                              | 372.00                 | 5.9                          | 86.9                        |
| 14-15                          | 8                    | 36          | 42.8                  | 40.37                              | 322.96                 | 5.1                          | 92.0                        |
| 11-12                          | 8                    | 44          | 52.3                  | 23.12                              | 184.96                 | 2.9                          | 94.9                        |
| 12-x                           | 8                    | 52          | 61.8                  | 22.75                              | 182.00                 | 2.9                          | 97.8                        |
| 12-13                          | 8                    | 60          | 71.3                  | 6.25                               | 50.00                  | 0.8                          | 98.6                        |
| 1-x                            | 8                    | 68          | 80.8                  | 5.87                               | 46.96                  | 0.8                          | 99.4                        |
| 11-14                          | 8                    | 76          | 90.3                  | 2.50                               | 20.00                  | 0.3                          | 99.7                        |
| 1-12                           | 8                    | 84          | 100.0                 | 1.37                               | 10.96                  | 0.2                          | 99.9                        |
|                                |                      |             |                       | 785.48                             | 6283.84                | 99.9                         |                             |

township would leave a gap of 2 miles in the system of intertownship roads.

#### ORDER OF CONSTRUCTION OF LATERALS

Having completed the 12-mile system, then the order of construction of laterals would be first 13-14, second 13-x, third, 12-x. Notice that these roads do not parallel any part of the original system at a distance of less than 2 miles. Further, such parallel roads as 1-12 and 1-2, and 12-13 and 2-3, 11-14 and 11-10 are almost negligible so far as traffic from the farm to the town is concerned. They are used for travel between farms.

Passing to the second set of assumptions made, it is found that road 14-13 carries actually more traffic than 13-24. Consequently, it would appear still more important to build the spur road before the system is completed. But, as before, the construction of 13-14 as a type requires the construction of 8 miles, while the completion of the system by the construction of 13-24 requires the construction of but 4 miles. Further, the completion of a system at once accommodates and attracts through traffic, so that it is probable that, once built, road 13-24 and the group of which it is typical would become more important than 14-13. Again, the system of 12 miles, including the 13-24 group, carries a heavier traffic than any other system of 12 miles that can be selected.

#### RELATIVE IMPORTANCE OF ROADS SHOWN GRAPHICALLY

By plotting the various roads so as to show their relative importance as typical of their respective groups, we see that the first group of 4 miles to be built would be 4.6 times as important as the third group of 4 miles and about 1.7 times as important as the second group of 4 miles. Further, the remaining roads in the system rapidly become of more uniform but of much less relative importance.

This plot shows graphically the powerful incentive and its basis in sound reason for the high-class improvement of a few miles of road. It becomes apparent that for every dollar spent on the last 8 miles of a group of 76 miles there can be economically expended \$298 on the first 4 miles of the group. Development of this point of view will furnish a powerful argument for the proper distribution of major expenditures of either annual road revenue or of the proceeds of a bond issue.

## Area of Croton Watershed Is Corrected

Old Figure of 360.44 Square Miles Above New Croton Dam Is Superseded by Value of 375 Square Miles

**I**NCORRECT figures for the area of the Croton watershed, from which New York City obtains the bulk of its supply, have been disclosed by investigations conducted during the last six years by the New York Department of Water Supply, Gas and Electricity. The revised figures fix the area above the new Croton dam at 375 square miles, instead of 360.44 square miles, the previously accepted value. The following statement regarding the revision, made for the benefit of those who make use of the Croton rainfall and runoff data, has been received from William W. Brush, acting chief engineer of the water department:

The area of the Croton watershed lying

above the old Croton dam has been generally reported as 338.8 square miles for the last fifty years or more. To this area was added 21.6 square miles as tributary watershed between the old Croton dam and the new Croton dam, making the generally reported area of the Croton watershed lying above the new Croton dam as 360 square miles. In 1916 the engineers of the Bureau of Water Supply were convinced that these areas were incorrect, and as a result of investigations made during the past six years adopted 375 square miles as representing the correct area of the Croton watershed lying above the new Croton dam.

#### HISTORY OF THE WATERSHED SURVEYS

In 1857-58 a survey was made of the Croton watershed lying above the old Croton dam, and on page 12 of the annual report of the Croton Aqueduct Department, made to the Common Council of the City of New York, bearing date of Jan. 3, 1859, is found the following statement, which first came to the notice of the department in 1914: "The total area or watershed of the Croton above the commencement of the aqueduct is ascertained to be 352 square miles."

The watershed map prepared as a result of the survey was lithographed by J. Bien, then of 24 Vesey Street, about 1860. The title on this lithograph is: "Topographical map showing the entire watershed of Croton River above the Croton Aqueduct Dam; also the most available sites for the storage reservoirs, from minute surveys made during the years 1857-58." A table, together with an outline of the various subdivisions of the watershed, appears on this lithograph. The subdivisions do not include all portions of the watershed, but at the bottom of the table is a statement that the total area of the watershed is 338.82 square miles. The lithograph bears a graphic scale of miles which is approximately 4350 feet per inch.

#### THE 1889 MAP

In the early '80s the Aqueduct Commission had brought to its attention the probable inaccuracy of the 338.82 sq. miles as the area of the watershed, and on Jan. 23, 1889, authorized William E. Worthen, a well-known engineer of that time, to prepare a topographical map of the watershed, this map including also the area between the old and new Croton dams. Six field parties were immediately placed on the work under the direction of C. C. Vermeule and J. R. Bien, the latter being in charge of the primary and secondary triangulations which were started from and afterward checked on monuments and bench-marks of the United States government and of the aqueduct commission. As a result of these surveys a map was drawn on eight sheets, to a scale of 3 in. to the mile, bearing graphic scales of feet and miles, with parallels of latitude and longitude at intervals of one minute. This map bears the title "Aqueduct Commissioners' Topographical Map of Croton Watershed." Twenty-foot contours throughout and beyond the limits of the watershed are given, with numerical elevations at all summits, depressions, water levels, etc. The watershed line is well defined.

This map was finally delivered on July 24, 1889, and in 1890, by carefully scaling the parallels of longitude and latitude, using the graphic scale on the map, computing the areas of the various zones

and adding to them in planimetric areas of the adjacent irregular portions, the following areas were obtained:

|                                                  | Square Miles |
|--------------------------------------------------|--------------|
| Area of new Croton watershed.....                | 375.815      |
| Area of old Croton watershed.....                | 352.84       |
| Area of watershed between old and new dams ..... | 22.975       |

Controversy immediately arose as to the accuracy of the newly determined areas. The area of 22.975 square miles between the old and new dams was reduced in the proportion that the newly determined area of the watershed above the old Croton dam bore to the area given on the lithograph previously referred to, thus obtaining a reduced area of 22.06 square miles by the following proportions: 352.84:338.82::22.975:22.06. The site of the new Croton dam was later moved slightly upstream and the adopted area above the new Croton dam was therefore changed to 360.44 square miles. Certain of the Aqueduct Commission engineers were never satisfied that this determination was correct, and from 1900 to 1903 the Aqueduct Commission used an area of 373 square miles, which was a compromise figure, and then returned to the figure previously used.

#### LATER CALCULATIONS

In 1909 calculations were made to determine, more correctly than by scaling, the area of the zones of latitude on the Worthen map, assuming the earth to be a sphere 40,000,000 m. in circumference at sea level and adding the planimetric irregular border. One meter was taken as equivalent to 3.280869 ft. The resultant area of the watershed was 374.979 square miles. Another computation was made at this time, following the method adopted by the U. S. Geodetic Survey, known as Clark's equivalent, with a resultant area of 375.55 square miles.

Since 1909 this matter has been considered from time to time, and it was finally agreed in the early part of 1916 by all the engineers now in the Bureau of Water Supply who had taken part in the investigation that an area of 375 square miles should be adopted.

The historical statement is largely based upon the notes kept by Assistant Engineer Jean P. Genthon, who was employed by the Aqueduct Commission since 1887, and who has conducted many of the investigations made of this subject, as well as performing the necessary computations both under the Aqueduct Commission and under the Bureau of Water Supply.

#### SUPPORTING DATA

The area of 360 square miles, previously used has its sole foundation on the printed area which appears on the lithograph copy of the map of 1858. The accuracy of this statement is disproved by (a) the printed report of the Croton Aqueduct Department for 1858, previously quoted; (b) by the planimetric and computed area of the watershed, shown on this lithograph of the 1858 map; (c) by errors found in the table of subdivisions given on the lithograph, the maximum error found being 10 square miles in an area given as 75 square miles, which should have been 85 square miles.

The newly adopted area of 375 square miles is supported by the following:

(a) By the area of the watershed determined from the lithograph of the 1858 map, using the graphic scale appearing on the

lithograph and the outline of the watershed as defined thereon.

(b) By the statement appearing in the annual report of the Croton Aqueduct Department for 1858.

(c) By the areas determined from the Worthen map by different methods which vary by less than 1 square mile.

#### REASON FOR CHANGE

The Department of Water Supply, Gas and Electricity has changed the area for the watershed because it believes that an error in the watershed area of the Croton River should be corrected in justice to the engineering profession, which has in the past made and probably will in the future make frequent use of the record of rainfall and runoff of the Croton watershed, which constitutes one of the most valuable and most widely consulted watershed records in the United States.

It has not been considered necessary to attempt further field investigations, as there is no material difference in all the data that have been secured bearing on the area of the Croton watershed. The only difference appears in a note on a lithographed map, and this note is flatly contradicted by a printed statement which was undoubtedly based on the original map from which the lithograph was made, and the lithograph itself does not in any way uphold the note in question which appears thereon.

## Springfield Coliseum Roof Supported by 200-Foot Arches Without Tie Rods

Rapid Erection of Steel Arch Trusses Marks Construction of 200 x 300-Foot Building—Foundation Piers Designed to Resist Arch Thrusts

MAIN arch trusses spanning nearly 200 ft., without tie rods at the floor level, support the roof of the Coliseum now being constructed as the main structure of the group of buildings being erected this year for the Eastern States Agricultural and Industrial Exposition at Springfield, Mass. The concrete foundation piers were designed to resist the arch thrusts, later modification in the design being required because of difficult foundation conditions. Furthermore, the main walls were supported upon reinforced-concrete beams connecting the arch piers, thus insuring a greater load on these piers to aid in resistance to sliding.

After the delay due to difficulties with high water in the foundation work, rapid progress was made in erecting the main steel frame and arch trusses. The ten trusses, which weighed about 30 tons each, were erected in about ten working days.

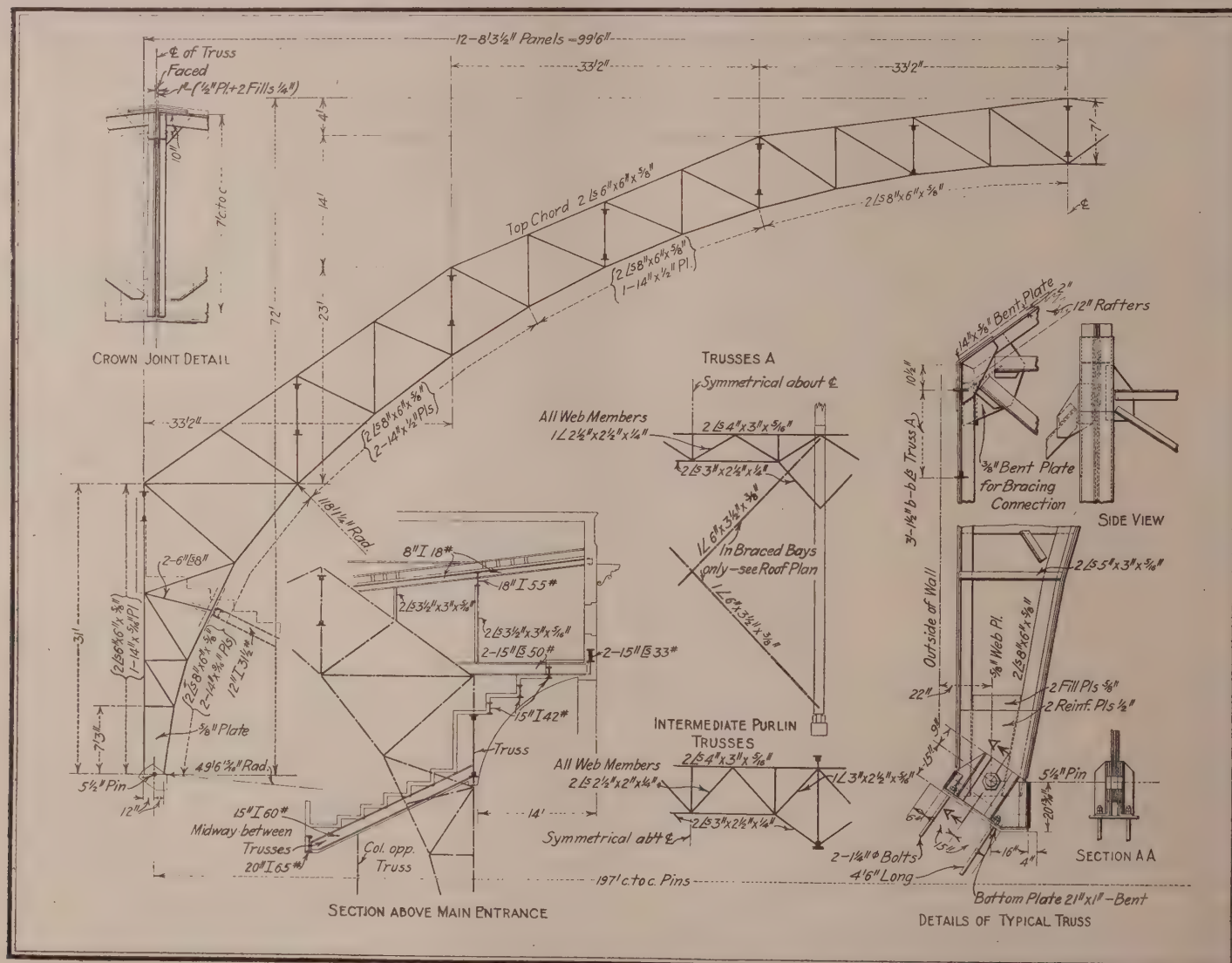
The Springfield Coliseum, so called, is the central structure of a group of eighteen or twenty buildings as planned, ten of which are to be erected this year. The other buildings are of ordinary mill construction, with brick walls. The central building is 200 x

305 ft. in plan and contains lecture rooms and exhibit spaces. Sloping amphitheater seats entirely surround a central space 96 x 200 ft. in size.

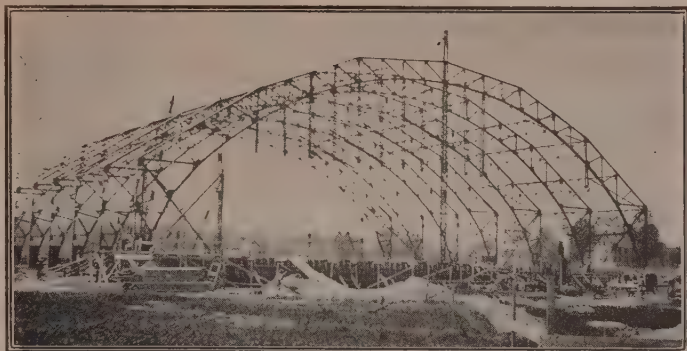
#### GENERAL PLAN AND DIMENSIONS

Ten steel trusses spanning 197 ft. center to center of end pins and 72 ft. high support the main roof, which contains skylights in the interior bays. The spacing and form of these trusses were determined mainly by architectural considerations. The building is divided into eleven bays, and the end trusses carry the suspended framing for end walls, which in turn carries the I-beam rafters for the flat roofs in the end bays of the building. Diagonal angles in the plane of this roof, as shown in the quarter roof plan herewith, transfer wind pressure to the side walls.

The required excavation for lecture rooms and other purposes at the corners of the building precluded the use of tie rods between the ends of the end trusses 1 and 10. It was therefore decided to omit all tie rods throughout the building and make the foundation piers and end details practically



TYPICAL DETAILS OF MAIN ARCH TRUSSES—SPECIAL FRAMING OVER MAIN ENTRANCE AND SECTIONS OF PURLIN TRUSSES



SEVEN TRUSSES ERECTED—TRAVELER SEEN AT FAR END



ERECTION TRAVELER HAS TWO 95-FOOT BOOMS

the same throughout. Another consideration in the decision not to use tie rods was the fact that these rods would be within 2 ft. of the finished floor grade, which might seriously interfere with the installation of ammonia pipes and the use of the floor for ice skating or for marine basins in exhibits. The main piers at the ends of the arches were therefore designed as arch abutments to take the thrust.

#### DESIGN OF MAIN ARCHES

The main arches were designed as three-hinged trusses, with the usual pin ends, but with an abutting joint at the crown, as shown in an accompanying drawing. Bearing plates and faced surfaces were used at the top-chord joint, and an expansion joint with bolts and slotted holes was provided at the bottom-chord joint. The purlins between the main trusses were made vertical, as shown, using triangular trusses instead of I-beams both because estimated to be more economical and because it was believed to improve the appearance.

The live loads used for the design of the roof were those prescribed by the Massachusetts law—varying from 40 lb. per square foot of horizontal projection to 30 lb. per sloping square foot, depending on the angle of slope. The unit stresses adopted conform to the A. R. E. A. specifications. The amphitheater seats were designed of reinforced concrete, but had to be redesigned of wood because of the excessive costs of labor and materials during the past year. The framing of the seats, except at the front entrance, is independent of the main framing of the building.

#### FOUNDATION PIERS AND BEAMS

The foundation piers for the arch trusses had to be modified twice to meet the conditions due to weather and river water. The site is located on the banks of the Westfield River, separated by a dike from the river water. Unusual high water this spring, however, created excessive pressure at the bottom of the foundations, so that the 3-in. sheet piling used could not hold it out. It was also found impossible to keep the water down by the use of force pumps, and finally it was found necessary to deposit the concrete under water by the use of orange-peel buckets opened very slowly so as to prevent washing. After about 3 ft. of concrete had been placed in this way, the remaining water was pumped out and the foundation poured in the usual manner.

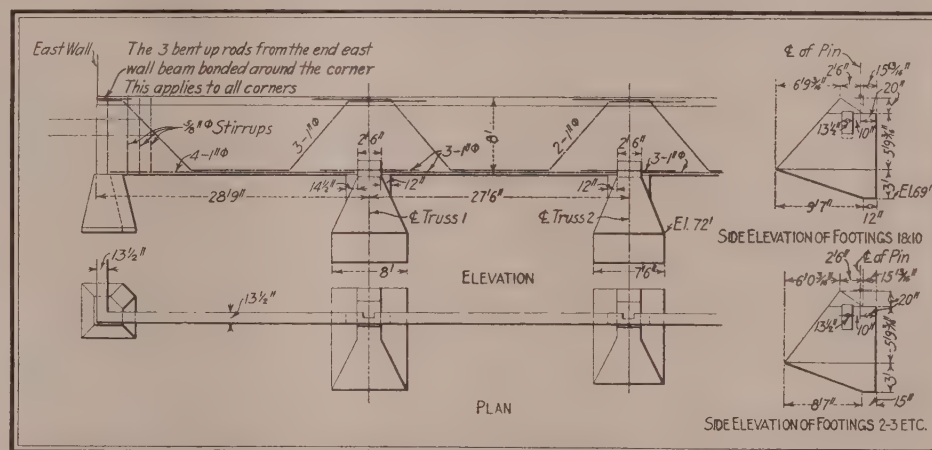
The changes in the design of the piers consisted essentially in making the bottom of the excavation level and depositing concrete to a depth of 2 ft. on the front or interior face and to a depth of 5 ft. on the rear face, the top surface of this mat then being perpendicular to the thrust of the

arch. Five foundations in the rear were placed in this manner, when it was found possible to make the sloping surface at the bottom by excavating carefully under water with an orange-peel bucket. The 3-ft. mat was then deposited under as described above, the water pumped out and the remainder of the foundation cast.

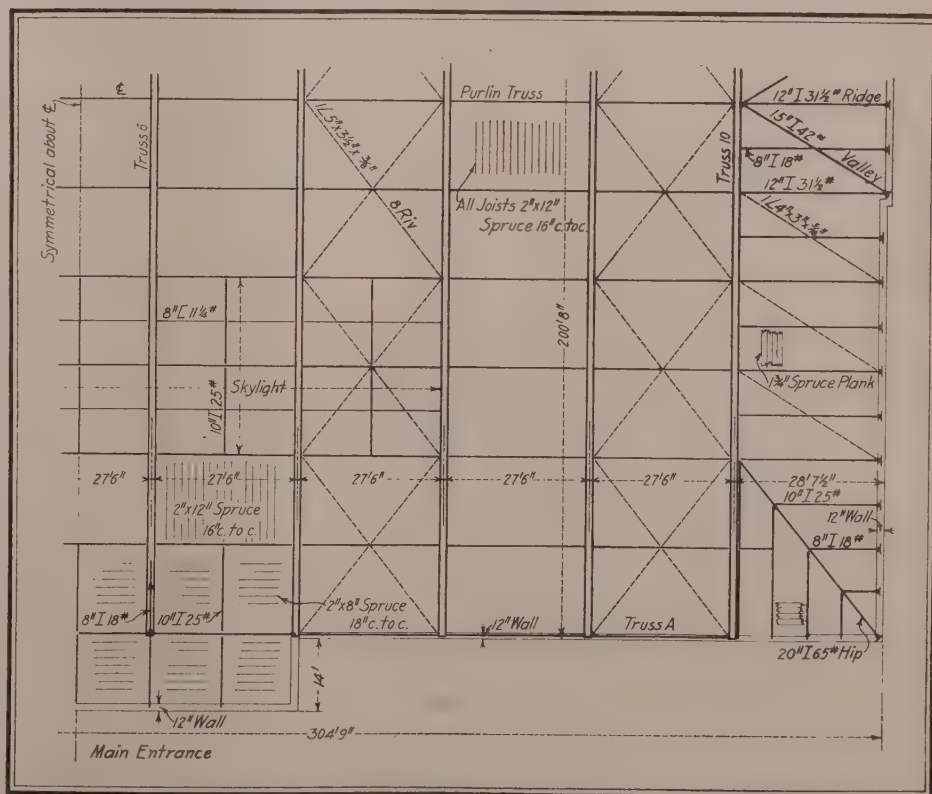
The character of the soil,  $3\frac{1}{2}$  to 4 ft. of loam,  $3\frac{1}{2}$  to  $4\frac{1}{2}$  ft. of fine yellow sand

(water at 7-ft. depth) and 3 ft. of river silt underlaid by coarse gray sand, made it economical to use reinforced-concrete beams between the main piers to support the outside brick walls of the building. These beams, shown in an accompanying drawing, varied from 8 to 9 ft. in depth, and were cast with pockets to allow the main trusses to be placed.

Rapid erection of the ten steel trusses was



FOUNDATIONS FOR MAIN TRUSSES DESIGNED TO RESIST ARCH THRUST



QUARTER ROOF PLAN SHOWS BRACED BAYS AND LOCATION OF TRUSSES

accomplished by a special traveler, 40 x 40 ft. in plan, with two stiffleg derricks having 80-ft. booms and 15-ft. outriggers, making a total length of boom of 95 ft. As the contract was let on March 8, and the entire erection was to be accomplished by June 8 under a penalty of \$300 a day for the steel contractors, it was planned to begin erection of the steel trusses on May 10. Actual erection began on May 12, being delayed by the completion of the foundations, the truss shoes having been very carefully set by stretching a line over the pins, which were inserted in the holes. These pedestals were set on shim plates and grouted in position after being accurately tested. This accuracy greatly facilitated the erection. By May 28, with four days' idleness because of rain, the entire ten trusses were in place, and by June 6 the riveting was completed.

The exposed site, with strong winds, especially in the spring of the year, made it essential to hold the first two trusses securely in place during erection. The first truss was therefore held by the booms of two guy derricks used as ginpoles; the end posts were placed first and securely guyed, the next two sections on each side erected with the ginpoles and the two center sections raised by the traveler. This was done by May 18. With the whole truss thus securely guyed and the ginpoles still hooked up, the wind pressure was easily resisted. The traveler was moved and the end posts of the next truss erected. One half-truss was then hoisted complete by one boom of the traveler, and the other half by the other boom. The truss was bolted, guys were placed at the peak and two truss purlins on each side connected up. The booms were cut loose and the remaining purlins placed. This operation was then repeated until the trusses were completely erected.

#### DESIGNING AND CONSTRUCTION PERSONNEL

The building was designed by the architect, James H. Ritchie of Boston, supervising the engineering and architectural features. Associated with the architect on the engineering work were C. R. Perry, H. D. Billings and G. L. Dudley, of Boston. The steel was fabricated and erected by the Levering & Garrigues Company, of New York City. Fred T. Ley & Company, Inc., of Springfield, Mass., are the general contractors, with George S. Jewett superintendent on the work. The erection traveler was designed by J. M. Bell, vice-president, and the erection was superintended by Robert F. Gadd, New England manager of the Levering & Garrigues Company.

#### Road Conditions in Pennsylvania

Pennsylvania was found to have 2.22 miles of road per square mile of area—more than either of the other two Middle Atlantic states. The total mileage on Jan. 1, 1915, was 91,555.84, of which approximately 10,000 miles, or 10.9 per cent, were surfaced. The state had a highly organized highway department with 10,200 miles of road, designated as state highways, directly under its supervision and maintained at state expense. Contributions for maintenance were also made for some roads other than those designated as belonging to the state system. Although complete information in regard to revenues was not available for some jurisdictions, an estimate of road expenditures in the state for 1914 places the amount at more than \$10,000,000, an increase over 1904 of 113.2 per cent.

## Nitrogen Recovery from Sewage Sludge Reaches Commercially Practicable Stage

William R. Copeland, at American Chemical Society Meeting, Tells How Profits in Fertilizer Products May Be Expected from Activated-Sewage Wastes

THAT the recovery of nitrogen from sewage sludge has at last been brought within the range of commercial practicability was the impressive statement made by William R. Copeland, chemist in charge of the Milwaukee sewage-testing station, in a paper presented last week before the division of water, sewage and sanitation of the American Chemical Society, which held its annual convention in New York City, Sept. 25 to 30. The reclaiming of this byproduct for sale as fertilizer at a profit, it was held, is made possible by the development of the activated-sludge process of sewage treatment, for the sludge produced in plants of this type has been found to contain more than twice as much nitrogen as is present in sludges from Imhoff or plain sedimentation tanks. Extracts from Mr. Copeland's paper follow:

#### WHAT THE TABLES SHOW

Data given in tables accompanying Mr. Copeland's paper show that the sludge which has been obtained heretofore by the best known processes of sewage treatment (plain sedimentation, septic and Imhoff tanks) contained from 1.2 to 3.0 per cent of nitrogen. These figures are low and indicate that the sludge did not possess as much nitrogen as the amount contained by the raw sewage would lead us to expect. This condition may be explained by the fact that a large share of the colloidal matter carried by the sewage ran out in the effluent flowing away from the tanks and took nitrogen with it. In the case of chemical precipitation works the lime added drove nitrogen off in the form of ammonia and diluted the portion remaining by increasing the amount of inert mineral matter. Moreover, various authors state that from 10 to 60 per cent of the volume of the solids deposited by sewage in the sludge-digestion chambers of Imhoff tanks and other forms of septic tanks is converted into soluble or gaseous form. Much of the albuminoid ammonia is thus changed into free ammonia and free nitrogen which escape in the liquor or bubble out at the gas vents.

Within the last two years, however, a new method of sewage purification by the so-called "activated-sludge" process has been tried out in various cities of America and England. One of the distinctive features of this process is that the colloidal and suspended matters of the sewage are collected in the sludge. If this is not reaerated or overaerated the solids are not liquefied to such a large degree as they are in septic tanks, and therefore the nitrogen does not escape.

#### RATE OF SLUDGE ACCUMULATION

For example, the digested sludge accumulates in Imhoff tanks at a rate of from 4 to 10 cu. yd. per 1,000,000 gal. of sewage treated, whereas by the activated-sludge process 20 to 80 cu. yd. or more may be deposited in the settling tanks, varying widely, of course, with the strength of the sewage and the water content of the sludge.

The Milwaukee sewage-testing station carried on a series of experiments during the summer of 1915 where the city sewage

was treated by the Imhoff and activated-sludge processes simultaneously. Analyses of the sewage effluents and sludges are given in Table 1.

Samples of digested sludge from the Imhoff tank and of the fresh activated sludge were also collected and analyzed in August and September. While it is not correct to

TABLE 1—ANALYSES OF MILWAUKEE CITY SEWAGE BEFORE AND AFTER TREATMENT BY IMHOFF TANK AND BY ACTIVATED SLUDGE

| PARTS PER MILLION    |                                 |                  |              |         |         |           |           |
|----------------------|---------------------------------|------------------|--------------|---------|---------|-----------|-----------|
| Period of test, 1915 | Source of sample                | Suspended matter | Nitrogen as— |         |         |           |           |
|                      |                                 |                  | Free         | Ammonia | Organic | Ni- trite | Ni- trate |
| August:              |                                 |                  |              |         |         |           |           |
|                      | Sewage .....                    | 253              | 14.6         | 7.88    | 29      | 0.15      | 0.13      |
|                      | Imhoff effluent .....           | 105              | 16.2         | 6.10    | 27      | 0.19      | 0.13      |
|                      | Activated-sludge effluent ..... | 14               | 3.8          | 3.19    | 6       | 0.29      | 6.00      |
| September:           |                                 |                  |              |         |         |           |           |
|                      | Sewage .....                    | 300              | 13.5         | 8.81    | 29      | 0.25      | 0.14      |
|                      | Imhoff effluent .....           | 116              | 15.4         | 7.10    | 27      | 0.12      | 0.09      |
|                      | Activated-sludge effluent ..... | 8                | 5.7          | 2.22    | 9       | 0.24      | 5.01      |

say that these sludges represent all of the raw sewage passed through these tanks during August and September, it is fair to assume that they are typical of the sludge which was being produced by those processes at that season of the year. Therefore the analyses of the sludges are given in Table 2.

The data given in Table 1 show some interesting facts. For example, the Imhoff effluent contained on an average more than 100 parts per 1,000,000 of suspended matter, whereas the effluent from the activated-sludge process contained only about 10 parts per 1,000,000. The Imhoff effluent contained more free ammonia than the raw sewage, whereas the activated-sludge effluent contained only one-third as much. The Imhoff effluent contained almost as much albuminoid ammonia as the raw sewage, whereas the activated-sludge effluent con-

TABLE 2—ANALYSES OF SAMPLES OF IMHOFF AND ACTIVATED SLUDGES OBTAINED FROM MILWAUKEE SEWAGE

| Date, 1915 | Source of sample | Nitrogen reported as NH <sub>3</sub> on basis of sludge dried to 10 per cent of moisture |
|------------|------------------|------------------------------------------------------------------------------------------|
| August:    |                  |                                                                                          |
|            | Imhoff sludge    | 2.87                                                                                     |
|            | Imhoff sludge    | 3.82                                                                                     |
|            | Activated sludge | 5.71                                                                                     |
|            | Activated sludge | 4.97                                                                                     |
|            | Activated sludge | 7.04                                                                                     |
| September: |                  |                                                                                          |
|            | Imhoff sludge    | 3.88                                                                                     |
|            | Activated sludge | 8.69                                                                                     |
|            | Activated sludge | 9.00                                                                                     |

tained only about one-third as much. The Imhoff effluent contained almost as much organic nitrogen as the raw sewage, whereas the activated sludge contained only one-third as much.

What became of the nitrogen carried by the sewage? Evidently most of the nitrogen in the sewage treated by the Imhoff tank passed out in the suspended and colloidal matters carried by the effluent. The activated-sludge process, on the other hand, converted the free ammonia into nitrate and stored up the undissolved albuminoid ammonia and organic nitrogen, as indicated by the large amount of nitrate in the effluent and high nitrogen content of

the activated sludge. In short, analyses of this material when dry show that activated sludge contains from 4 to 4½ per cent of nitrogen, and sludge from certain industrial plants such as packing houses may carry even more.

When it comes to recovering this nitrogen, however, we meet with a serious difficulty, because as the sludge gathers in the settling tanks it contains from 98 to 99 per cent of moisture, and the bulk of this water must be removed before the dry material can be sold for fertilizer. Several methods of dewatering the sludge have been tried, such as settling, passing the mixture through centrifugal machines, pressing and drying.

#### COMBINATION OF SETTLING AND DECONTATION

The best information now available points to a combination of settling and decantation as a preliminary process. By this means the water will be cut down from about 99 to 96 per cent. On passing the concentrated residue through a press the moisture can be cut down to 75 per cent. The press cake can be dewatered in a drier to 10 per cent of moisture or less.

More than thirty samples of activated sludge have been dewatered by sedimentation, decantation and pressing at Milwaukee. It is an interesting and notable fact that two different types of press can handle the settled sludge without requiring the addition of lime. Many experts and manufacturers of presses have held heretofore that sewage sludge could not be pressed advantageously without lime because of the gummy or gelatinous nature of the colloids in the sludge; but the facts remain that the sludge is not as gummy as was expected and it presses fairly easily down to 75 per cent of moisture.

In order to try out the feasibility of further dewatering the sludge four samples of the press cake were sent to fertilizer plants and dried there on a commercial scale. Three of these tests were made in a steam-jacketed (indirect-heat) drier and one in a semi-direct heat drier. In each case the tests proved to be successful from three standpoints: (1) The sludge dried readily to a satisfactory mechanical condition; (2) the processes did not require much power; (3) little nitrogen if any was driven off or lost by drying. From the mechanical standpoint therefore the recovery of nitrogen in sewage sludge is practicable.

#### THE QUESTION OF COST

With regard to the question of cost, however, the situation at the time of writing is not so clear. The pieces of apparatus used for settling the raw sludge and drying the press cake were not designed to handle activated sludge in the most economical manner, but were requisitioned as being the best commercial apparatus available at the time. By comparing the behavior of activated sludge with such matters as packing-house tankage Mr. Copeland estimates that this sludge can be dewatered so that the recovery of the nitrogen in it will probably cost, upon present evidence, about \$8 to \$12 per ton of material containing 10 per cent of moisture, depending on a variety of local factors. These figures are intended to cover interest charges, depreciation, repairs and renewals, and a liberal provision for labor and fuel, as well as the cost of resettling and decanting of the water of the

original sludge, and expenses for handling, freighting, and marketing the finished product. Obviously, the total cost per ton will be somewhat more in the case of a small plant than for a large one. For a very large plant, where fuel and labor are relatively cheap, it is possible that further experience will reduce the cost below the lower limit in the range here given.

The dried samples of sludge were analyzed and the data obtained are given in Table 3.

TABLE 3—ANALYSES OF COMMERCIAL DRIED ACTIVATED SLUDGE (BASIS OF 10 PER CENT MOISTURE)

| Sample No.                | Character of drier    | Per cent of—        |                      |
|---------------------------|-----------------------|---------------------|----------------------|
|                           |                       | Nitrogen as ammonia | Available phos. acid |
| 1                         | Semi-direct heat..... | 4.36                | 0.70                 |
| 2                         | Indirect heat.....    | 4.76                | 0.81                 |
| 3                         | Indirect heat.....    | 4.56                | 0.47                 |
| 4                         | Indirect heat.....    | 5.06                | 0.39                 |
| Average of 4 samples..... |                       | 4.68                | 0.57                 |

These analyses may be supplemented by the following tests in Table 4:

TABLE 4—SOME ADDITIONAL ANALYSES OF ACTIVATED SLUDGE PRESS CAKE

| Date of collection | Per cent of nitrogen calculated to ammonia (basis of 10 per cent moisture) |  |
|--------------------|----------------------------------------------------------------------------|--|
|                    |                                                                            |  |
| May 8, 1916.....   | 5.74                                                                       |  |
| June 20, 1916..... | 4.65                                                                       |  |
| June 13, 1916..... | 4.88                                                                       |  |
| June 14, 1916..... | 4.92                                                                       |  |
| June 16, 1916..... | 5.01                                                                       |  |

The data obtained at Milwaukee as cited in Tables 3 and 4 indicate that dry activated sludge (basis of 10 per cent moisture) will contain 4.6 to 5 per cent of nitrogen figured as ammonia and 0.6 to 0.7 per cent of available phosphoric acid. In addition to this the Milwaukee data show that the dry product contains about ¼ to ½ per cent of potash and from 3 to 4 per cent of fatty material. At present prices the nitrogen is worth \$2.50 per unit (or per cent). In normal times this nitrogen would be worth about \$2 per unit. The phosphoric acid is worth about 50 cents, and the potash may be worth something in the future, although the best that can be said of it at present is that it will assure for the fertilizer a more ready sale.

The fat present in the Milwaukee sludge is negligible. It would not pay to recover the fat, nor will the fat injure the selling qualities of the dried sludge.

#### SUMMARY

Summing the whole situation up, then, we see that the dried sludge has a market value upon present figures of \$9 to \$15 per ton of material containing 10 per cent moisture. The total cost of getting this product and placing it on the market will probably run from \$8 to \$12 commercially per dry ton, depending on local conditions. For large plants this cost may possibly be reduced as a result of further experience.

The activated sludge containing 4 per cent or more of nitrogen is much nearer a commercial possibility than the sludges obtained by the older methods of treatment, such as chemical precipitation, septic tanks, or the Imhoff process, which data indicate to contain only 1½ to 3 per cent of nitrogen.

In case the question arises as to the possibility of finding a market for the dried activated sludge, it should be added that raw materials containing nitrogen, phosphoric acid and potash are capable of being worked up readily as a base for making

high-grade fertilizers, and as they are not very plentiful they are in good demand. Presumably, however, large cities such as New York and Chicago, by installing this activated-sludge process, would produce so much raw material of this character that the product would have to be parceled out among a number of manufacturers. It is even possible that the production might be sufficient to reduce the price.

However, the dried sludge is a good fertilizer just as it stands and contains enough value to pay for sale and distribution in quite a large local market. The data given indicate therefore that the recovery of the nitrogen in sewage sludge has at last been brought within the range of a commercially practicable problem.

## Dewatering of Sludge the Big Byproduct Problem

Discussion by George W. Fuller of W. R. Copeland's Paper on the Recovery of Nitrogen from Sewage Sludge

FOLLOWING the presentation of W. R. Copeland's paper (reproduced substantially in full in the preceding article) at the annual meeting of the American Chemical Society in New York last week, George W. Fuller, consulting engineer, of New York City, submitted the following discussion:

#### COPELAND'S DATA DECISIVE

Mr. Copeland's conservative statements on his observations at Milwaukee add materially to our practical knowledge on this subject. With the advent of the activated-sludge method of treatment it appears, in Mr. Copeland's opinion, that the handling of sludge so as to use it in a dry form as a fertilizer has now come within the range of commercial practicability. But a careful perusal of this paper indicates that he does not entertain such views concerning the sludge obtained from other processes.

Generally speaking, the data of Mr. Copeland show that dry sludge from the activated-sludge process contains about twice as much nitrogen as the sludge from other processes. His data bearing upon this matter are probably more decisive than those which have been brought together hitherto, and he explains clearly why it is that activated sludge is richer in fertilizing properties than are other sludges.

#### MOST NITROGEN IN ACTIVATED SLUDGE

Experience showed years ago that plain sedimentation removes about one-third of the total organic matter in ordinary sewages and that chemical precipitation removes about one-half. That which is removed by these tankage treatments normally appears in the accumulated sludge. The balance passes out of the tank with the effluent.

Table 1 of Mr. Copeland's paper shows that with the activated-sludge method the removal of organic matter is in the vicinity of 70 per cent. This seems perfectly logical in comparison with the results of plain sedimentation, owing to the fact that the activated-sludge treatment removes colloids and other nonsettling organic matters.

The data in this table further indicate that the Milwaukee Imhoff tanks, with their relatively short period of sedimentation, removed less organic matter by deposition than does plain sedimentation in larger tanks, as tested in earlier years.

When we consider the nitrogen content of

Imhoff tank sludge—and the same would be roughly true for sludge of single-story septic tanks—it is necessary to recognize clearly, as pointed out by Mr. Copeland, that there is a material reduction in organic matter, due to the liquefaction and ultimate gasification of organic matters in a form permitting their direct release into the atmosphere. Obviously, septicization must mean a loss of the nitrogen content and hence of the fertilizing value of sludge.

On the other hand, activated sludge, reinforced with the nitrogen content of colloidal and nonsettling matters, is not only spared the loss of nitrogen but is actually able to show a substantial gain in nitrogen as a result of containing some of the more or less oxidized nitrogen. The removal of free ammonia as shown in Table 1 is quite striking. Part of it doubtless passes to nitrates, but it would be interesting to know what proportion of it becomes available for fertilizing purposes by adherence to the solid sludge as dried.

#### COMPARATIVE FIGURES

Figured on a commercially dry basis (10 per cent moisture), Mr. Copeland's average figures show a nitrogen content which is compared with some other data from activated-sludge tests, as follows:

|                                   | Per Cent Nitrogen |
|-----------------------------------|-------------------|
| Milwaukee data (Copeland).....    | 4.40              |
| Manchester, England (Ardern)..... | 4.60              |
| Salford, England (Melling).....   | 3.75              |
| Urbana, Ill. (Bartow).....        | 3.5-6.4           |
| Armour & Co. (Noble).....         | 4.6               |
| English range (Fowler).....       | 4.0-6.0           |

Attention is called to the fact that all of the foregoing figures are expressed in terms of nitrogen and not of ammonia, as seems to be the custom in speaking of the composition of tankage from garbage works. Nitrogen is only 82 per cent of the ammonia content, and care must be taken in dealing with the analysis. Mention should also be made of the fact that many published analyses refer to absolutely dry sludge, whereas most of the data recently refer to commercially dry sludge with 10 per cent of moisture.

From a commercial standpoint it is highly important to know whether the analyzed samples of sludge are representative or not of the annual output of the plant. Where sewage from a separate system of sewers is treated, this is not so vital a matter as in the instance of the sewage from combined sewers, where the amount of mineral detritus is bound to vary materially. Obviously, mineral matter dilutes the organic sludge with inert material which, pound for pound, costs as much to dry and prepare for the fertilizer trade as in the case of organic matter free of street wash and industrial wastes.

#### NITROGEN CONTENT AS PLANT FOOD

A good deal has been written, particularly in England, as to the availability of the nitrogen content as a plant food. It is not the intent to discuss that phase here, but it would appear that the activated-sludge method in this respect does not suffer by comparison with the sludge from other methods.

The availability of the nitrogen is discussed at some length in a paper by Dr. E. H. Tripp, describing the Dickson process of sludge treatment as practised at Dublin, Ireland, and printed in the *Journal* of the

Society of Chemical Industry, May 31, 1915. In Dr. Tripp's article the nitrogen in the dry Dublin sludge is given as 2.51 and 2.26 per cent in the two analyses published. It is interesting to note that the Dublin sludge is not nearly so rich in nitrogen as that obtained without the activated-sludge method, and the same is practically true of the Bradford sludge, which is described in the *Engineering Record* of Jan. 21, 1911, page 80, as having an ammonia content of 2.61 per cent.

#### DEWATERING IN THREE STAGES

It is an altogether different matter to dewater activated sludge obtained from a settling tank in a flocculent condition and mixed with 99 per cent of water from what is the case with Imhoff sludge containing 87 per cent of water and mixed with gas, so distributed as to cause practically all of the solid matters to rise and allow the withdrawal of subnatant water.

Clearly, the first step is to resettle and remove by decantation as much surface water as practicable, as described by Mr. Copeland. This, he says, at Milwaukee allows them to get sludge of about 96 per cent water content. To carry this resettling too far seems to be impracticable, owing, among other things, to the fact that the activated sludge after settling and during storage seems to undergo putrefaction within a period of 24 hours or less. Further aeration for 4 or 5 days would make this settled sludge nonputrescible; but this treatment results in the consumption of a substantial portion of the available nitrogen.

The real problem is to dewater this resettled product. Mr. Fuller has given a good deal of attention to this matter recently and offers comments concerning the two latter stages of dewatering, as follows:

Mr. Copeland describes the use of Worthington presses for reducing the water content from about 96 to 77 per cent. Based on general experience, it will cost for a fairly sizable plant about \$3 per ton of absolutely dry solids for pressing. For commercially dry sludge with 10 per cent moisture this figure would be about \$2.70 per ton. This makes no allowances for interest, depreciation, or overhead charges.

#### YEAST-FERMENTATION PROCESS

The Dickson yeast-fermentation process might allow this result to be accomplished at a much lower figure, although Mr. Fuller is not prepared to give any cost data at present. Within the past few months he has had opportunity to investigate, in behalf of New York bankers, a test plant built in Brooklyn under the eastern end of the Williamsburg bridge for treating about 500,000 gal. of sewage per 24 hours according to the Dickson process which was originally installed at Dublin, Ireland. The sewage is subjected to plain sedimentation in hopper-bottom tanks from which the sludge is removed at intervals and a portion of the water removed by further sedimentation. This sludge, with 92 to 96 per cent of water, is mixed with about  $\frac{1}{2}$  per cent of brewers' yeast and allowed to ferment for about 24 hours in long, narrow round-bottom, sloping tanks, which are jacketed and kept heated to about 90 deg. Fahr. Anaerobic bacteria decompose the yeast cells and cause the sludge to become so mixed with entrained gases that the solid matters rise to the top in a manner similar

to that noted with Imhoff tank sludge, and a fairly clear subnatant water is removed through a perforated pipe at the bottom of the tank. The water content of the remaining sludge averaged about 80 per cent, according to analyses made by Hill and Ferguson, but some samples showed 75 per cent, which, with improved devices, could probably be obtained regularly.

No activated sludge has been treated at this plant, which has been shut down for several weeks pending changes. It is proposed to treat activated sludge as soon as material is obtained from the Brooklyn testing station. So far as known there appears to be no reason why activated sludge cannot be dewatered by the yeast-fermentation process in a manner similar to that experienced with the sludge of plain sedimentation tanks, as is being installed on a large scale by Mr. Watson at Birmingham, England.

#### SLUDGE DRYING

Mr. Copeland refers to both indirect-steam driers and direct-heat driers, with results which promise practical success for reducing the water content from about 75 to 10 per cent. Much weight should be attached to the fact that success has attended the drying of wet products in other industries, such as garbage tankage and refuse from stock yards, packing plants, etc. To drive off 4 to 6 lb. of water with 1 lb. of coal seems to be attainable with the devices now on the market. Some manufacturers seem willing to guarantee a removal of 10 lb. of water for 1 lb. of coal. A test guarantee of 8 lb. evaporation seems reasonable, according to the conclusions arrived at in the office of Mr. Fuller, but in practice it would probably be wise to make some allowance for waste heat, which is characteristic of all plants of this general character.

Whether or not it would be worth while to use an indirect steam drier for removing a portion of the water and then finish the drying in a direct-heat type of machine is a point perhaps worthy of discussion and upon which Mr. Fuller has reached no final conclusion.

#### DRIER AT WILLIAMSBURG UNSUCCESSFUL

The drier of the Dublin type as operated at the Williamsburg test plant did not prove very satisfactory in several respects. One of the principal difficulties was that the sludge contained more or less fibrous material, which formed lumps or balls which were not crushed by the stirring arrangements in this drier, with the result that they passed out through the outlet into the disintegrator. The water was not removed from the interior of these lumps as they left the drier, but they were fairly well dried in the disintegrator. In the effort to dry out these lumps there were occasions when the sludge caught on fire, so that it would burn, and have its fertilizing value lessened if the fires were put out with water, which of course increases the amount of coal used for dewatering.

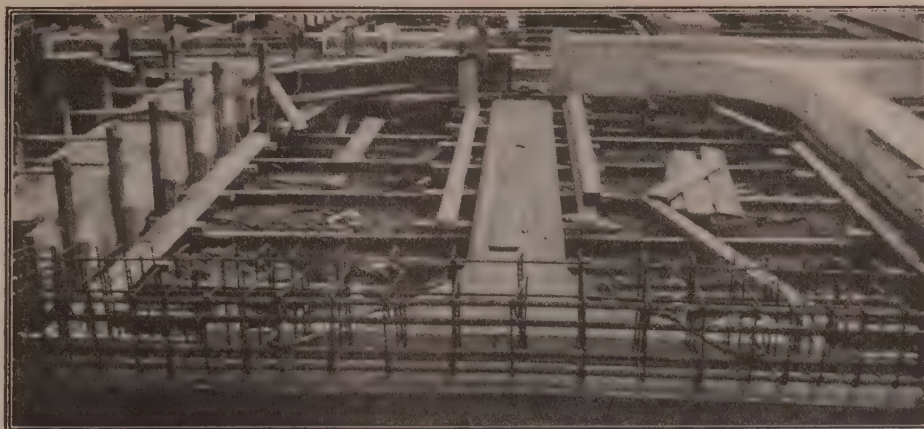
The foregoing comments are made, not with a view to intimating that sludge-drying is commercially impracticable, but to suggest that there are mechanical details yet to be carefully studied as the process is not so simple as one would gather from reading Mr. Ruggie's article in the *Engineering Record* of Jan. 21, 1911, page 79, describing experiences at Bradford, England.

## Canopies at Denver Station Are of Precast Units

One Locomotive Crane Places Concrete in Slabs and Columns, Stacks Units in Yard and Erects Them at Station

TWO SETS of units—one column unit supporting one end of each of four similar slab units—make up the canopies of the remodeled union station at Denver. The members are cast in place in a yard about  $\frac{1}{4}$  mile from the station, one locomotive crane traveling up and down the yard placing the concrete, transferring the units from the forms to the curing stacks, moving them from there to flat cars and finally erecting them in the canopies.

There are 7000 lin. ft. of canopies. The photographs make it unnecessary to describe them in detail. The columns are 16 x 12 in. and 16 ft. 4 in. high, including 3 ft. bedded in the platforms and footings. The top beams are 11 ft. long. The slabs,



COLUMN FORMS ON RAILS IN DOVETAILED ARRANGEMENT TO ECONOMIZE SPACE

in six days. Columns are poured once a week and left on the bottom form for a period of three weeks.

All forms are of wood covered with galvanized iron. Two carpenters can set up a side form for a slab in 20 minutes.



LOCOMOTIVE CRANE LIFTS SLAB FROM CAR AND PLACES IT IN CANOPY



SLABS ARE SPRINKLED DAILY FOR TEN DAYS—STACKED SIX DEEP

each of which forms a half section of the canopy, are 9 ft. 9 in. by 20 ft., and 3 in. thick, ribbed as the illustrations show. The slopes of the two roof surfaces are respectively  $\frac{1}{2}$  in 12 and 3 in 12. The canopies are 19 ft. 6 in. wide, the platforms 17 ft. 6 in., and the clearance from top of rail to edge of shed is 16 ft.

In the casting yard care has been taken to make the foundation perfectly rigid, so that the members will be true and interchangeable. The forms are laid on steel rails carried on ties. For the slabs there are three rails longitudinal with the slab, one under each beam and one under the outer edge. Under the columns a large number of rails are laid transversely. The column forms are dovetailed to save space.

In the yard are sixty-five slab bottoms and twenty-five column bottoms. There are about one-third as many side forms of each type, so that the fresh concrete remains on the bottom forms while two more sets of units are being cast, after which the members are stacked for curing, the bottoms being released for further use. Slabs are cast every other day and moved to the stacks



CRANE MOVING UP AND DOWN YARD FILLS FORMS FROM BOTTOM-DUMP BUCKET

The reinforcing for the column beams is built up outside. That for the slabs is laid in place. Along with the reinforcement are placed inverted U-rods for picking up the units with the crane.

The concrete, which is made 1:6, is mixed in a Cube mixer feeding into a ½-yd. bottom-dump bucket. The Industrial locomotive crane traveling along the yard picks up the bucket and delivers it as required. Thus a slab, which contains 3 yd., can be poured in 15 minutes.

The units are sprinkled every day for ten days. When the slabs have set sufficiently they are removed from the bottom forms by the crane and stacked six high, strips of lath being placed between them to prevent center-binding. When properly seasoned they are loaded on flat cars and set in place in the canopies, as shown in one of the photographs.

The canopies are being built by the Van Sant-Houghton Company of San Francisco, under the direction of J. G. Gwyn, chief engineer of the Denver & Rio Grande Railroad.

## Aëration Suggested for Disposal of Sludge

George T. Hammond Discusses Problems of Activated Process of Sewage Treatment Before American Chemical Society

"If we treat sewage by 'activation,' why may we not also find such a means of treating the sludge?" This is the line of thought suggested by George T. Hammond of the Bureau of Sewers, Borough of Brooklyn, New York City, in a paper presented last week before the division of water, sewage and sanitation of the American Chemical Society, which held its annual convention in New York, Sept. 25 to 30. The amount of sludge which must be disposed of, Mr. Hammond pointed out, easily stands first among the problems of the activated-sludge process of sewage treatment. This amount varies from 2000 to 4000 gal., or more, per million gallons of sewage, and the material has a water content of from 99 to 96 per cent. To minimize this surplus sludge Mr. Hammond sees possibilities in the use of fine screens and in some scheme of prolonged aëration. Extracts from his address are given below.

### DEWATERING EXPERIMENTS

Sludge from the activated method of sewage treatment is highly putrescible unless dewatered, which is an expensive operation. Success in dealing with this problem is reported by T. Chalkley Hatton of Milwaukee, but the details and cost data are not yet available. At the Armour & Company plant at the Chicago Stock Yards experiments are still under way with dewatering methods, but their conclusions are reported as not final. It seems to them, however, that a battery of vertical-flow settling tanks, which decrease moisture to 97 per cent, followed by a Worthington or similar press, is the best method up to the present. The sludge, after pressing, is dried by a direct or an indirect-heat drier to 10 per cent moisture, which is necessary in order that the material may be used in making fertilizer. The cost of this method, according to Mr. Hammond, is such that the commercial value of the product must be considerable in order to make the treatment available. If means of transporting the dried product to market are costly, or fail at a

critical moment, serious trouble may arise.

"Our further analyses of the sludge for fertilizer value," writes Mr. Noble of Armour & Company, "show it will run between 4½ and 5 units of ammonia, the value of it being therefore about what we have previously estimated—\$9 to \$10 per ton in the dried state." These figures, Mr. Hammond explained, refer to the sludge derived from the stock-yard sewage, and will probably not be equaled with ordinary domestic sewage.

### REMOVAL OF SUSPENDED MATTER

It is quite probable, Mr. Hammond believes, that this difficulty can be overcome to a considerable extent by means directed to the removal of sludge-producing material from sewage previous to the treatment—for instance, by screens or tanks. So far no complete data are obtainable on this point, but experiments seem to justify the expectation of success. Experiments are needed to show how fine such a screen should be, for if it removes too much suspended matter the process may be seriously interfered with. So far as Mr. Hammond's experience goes the Imhoff tank is not likely to prove as successful as the screen in this preliminary treatment, as the tank takes out too much of the best size material in suspension for the activation process. But this is not stated as having been proved conclusively. If an Imhoff tank is used, the surplus activated sludge might be reduced to the condition of Imhoff sludge by being introduced into the digestion chamber, as suggested by Leslie C. Frank.

While the conditions at Milwaukee are rather unique, and favorable to the activated-sludge method, as well as to the transportation of the dewatered sludge, it is doubtful, in Mr. Hammond's opinion, if other cities less favorably situated will feel justified in going to the expense of installing extensive plants for dewatering sludge. The combination of a commercial venture with sewage disposal need not necessarily prove a failure, but the chances against its success do not make the project seem attractive.

### REDUCTION OF MOISTURE

A recent communication from Mr. Hatton states: "After elaborate experiments on the dewatering of sludge and sludge drying we find that there is little of the problem connected therewith that has not already been solved in industrial establishments where material of like character must be treated. Either of two kinds of presses will reduce the moisture from 99 to 75 per cent, and there is no difficulty by either the direct or indirect drier to reduce this moisture from 75 to 10 per cent or lower."

This statement is of great interest and seems very promising. It seems to Mr. Hammond, however, that in most places the problem will always be how to minimize the formation of surplus sludge and how to get rid of what does form without dewatering it in a plant especially provided for this purpose. If it costs more per ton to dewater than the sludge will sell for, or the net value obtainable therefor, then even though the value figures at \$9 to \$10 per ton, few will care to undertake such a venture, or at least go farther than what would be the fair cost of sludge disposal by other means.

Dewatering sludge is a matter of difficulty and expense and cannot but add a burden to the maintenance of a plant. This

may be provided for in large plants, if the value of the sludge recovered warrants, but in small plants it would probably lead to a nuisance and would not be usually undertaken where the sewage amounts to less than 10,000,000 gal. per day.

### SLUDGE-DRYING PROGRESS

The Schaefer-ter-Meer centrifugal sludge drier, used on a large scale at Frankfort-on-the-Main, and at Hanover, in Germany, has been thoroughly developed as a sludge-drying machine, which can handle with success large volumes of sludge and dry it sufficiently to burn readily in an incinerator plant. This machine was experimented with at the Jamaica sewage-disposal plant on Long Island, N. Y., and tests show that operating on sludge containing 91.5 per cent of moisture, from a lime-precipitation tank, it effected a removal to 64.2 per cent moisture, and operated continuously while effecting this removal. The cost of this method, as shown by the tests, was rather high, but the tests were really not a fair exhibition of what these machines can do, as the sludge treated was limed sludge and entered the machine in a sticky state, not favorable for economical operation.

The Dickson method of sludge dewatering, which employs brewers' yeast to effect a separation of water and sludge, also offers a possible means of success, and has the advantage of a fully developed system by means of which the dewatering and drying can be carried from the commencement to the completion of the process, without extra handling between the various steps. The dried sludge leaves the apparatus in bags ready for shipment to the fertilizer factory, or may even be made a complete fertilizer ready for market as it leaves the plant.

So far the cost of these methods has not been determined for activated sludge, but Mr. Hammond believes it will be lower than the cost for drying ordinary sludge. It is quite possible that the sludge may be destroyed by a septic process where the amount of it is not great enough to make dewatering an attractive measure. But little study has been done in this direction and much is desirable.

### SUGGESTS SLUDGE AÉRATION

As the sludge tends to break up and dissolve with over-aëration, and in doing so diminishes in volume, this gives promise of still another method that so far has received but little study. It has been found that by means of long-continued aëration activated sludge may be broken up and reduced to 10 per cent or less of its original volume. The problem is to get rid of the water during this reduction, so as to decrease the volume to be aërated. That this may be done seems fairly possible.

"Taking the surplus activated sludge as a special problem, it would seem," states Mr. Hammond, "that we should be able to design a plant to reduce its putrescible contents by means of biological agencies. If we may treat the sewage by 'activation,' why may we not, also, find such a means of treating the sludge? Since we have found that long-continued aëration will reduce it to a very small volume, can we not find means of doing this without excessive cost for air?"

"We observe that after a short aëration period with activated sludge clarification of the sewage takes place, and that out of 1,000,000 gal. we have a net amount of

2000 to 4000 gal. of sludge, which we must dispose of separately, and this is about 99 per cent water. Clearly we can afford to aerate this small volume for a long time, if necessary, to effect its reduction to a form which will not cause a nuisance. Experiment shows that about half of this volume is free water which can be removed by an hour's tankage, and that 24 hours' aeration of the sludge will separate a large part of its remaining water, and the bacteria will keep on working for us. Thus we are continually treating a diminishing quantity of sludge, and the problem of design seems the principal problem."

## Dikes and Tide Gates Help Control Mosquitoes

Problem of Salt-Marsh Breeding Solved by New Jersey Commission — Costs \$437 per Square Mile

THE CAMPAIGN of mosquito control in New Jersey was begun in 1903, when the late Prof. John B. Smith, state entomologist, caused a section of the Newark salt marshes to be ditched. That experi-

tion of this style of drainage for mosquito control showed that while open ditches proved successful under ordinary weather conditions, in periods of continued rains coupled with high tides, egg development would begin, and frequently mosquitoes reached the adult stage before the water could be drawn into the ditches.

### DIKES SHUT OUT TIDEWATER

These abnormal weather conditions were overcome by shutting out the tidewater from the meadows with a system of dikes and tide gates. The work of diking the salt meadows in Essex County has been completed at a cost of \$5,110.51, and the effectiveness of this style of drainage for mosquito control during the breeding season of 1916 has been carefully observed. The commission is of the opinion that it has solved the problem of controlling salt-marsh-mosquito breeding through its system of dikes and tide gates. It has also decided to go a step farther in some of the low-lying meadows by connecting them with the Newark pumping station by a series of ditches. The water can then be pumped from the meadows whenever necessary.

While much of the effort of the commission has been devoted to the large salt-marsh areas of the county, the control of mosquitoes which breed in fresh water has not been neglected. Many large swamps have been drained, miles of brooks cleaned, and a general backyard inspection has been maintained each year. Practically no complaints of mosquitoes indoors were received during the past summer.

During 1915, 500,000 ft. of ditch were cleaned and 11 tide gates installed. The previous year witnessed the installation of 28 tide gates and the construction of 27,195 ft. of dikes, as well as the cleaning of 500,000 ft. of ditch.

## Crushed-Stone Roads Cost \$3,500 to \$4,500 Per Mile

Small First Cost and Maintenance Expense Necessary in Indiana — Highways Have Life of 15 or 20 Years

By R. L. LONGSHORE  
Deputy Surveyor, Adams County, Indiana

INDIANA'S present laws provide for the construction of good roads by means of bond issues based on the total assessed valuation of the township. As the total bonded debt of the township must not exceed 4 per cent of the total assessed valuation, the cost of unit miles must be kept low in order to construct roads over the entire township in a reasonable length of time.

After construction the roads are maintained by the county under the supervision



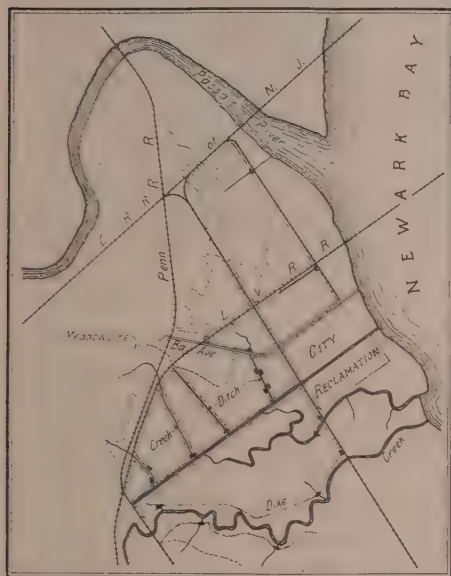
SECTION OF ROAD BUILT ON FILL

of a highway superintendent. The maintenance fund is raised by a levy on the entire county. Including state aid from automobile license, the fund amounts to only \$100 per mile per year. This takes care of all repair work, including material for the grading, sewer and culvert repair, and weed cutting. Because this fund is low it is necessary that a type of road be used on which not only the first cost but that of annual maintenance is a minimum.

### DOUBLE-TRACK ROAD TRIED FIRST

The first road tried in Adams County was a 24-ft. highway providing a 10-ft. crushed-stone pavement on the right side in the direction of the heaviest traffic and a 10-ft. earth side road. This type proved a failure, as it has been found impossible to maintain two radically different types of road on a 24-ft. subgrade. During wet or freezing weather the wheels of passing vehicles drag up mud from the earth-side road onto the stone, causing holes to "burn" through the metal. While the double track appealed to the public and is correct in theory, it has, in Indiana, proved impracticable, and in most cases the earth track is little traveled.

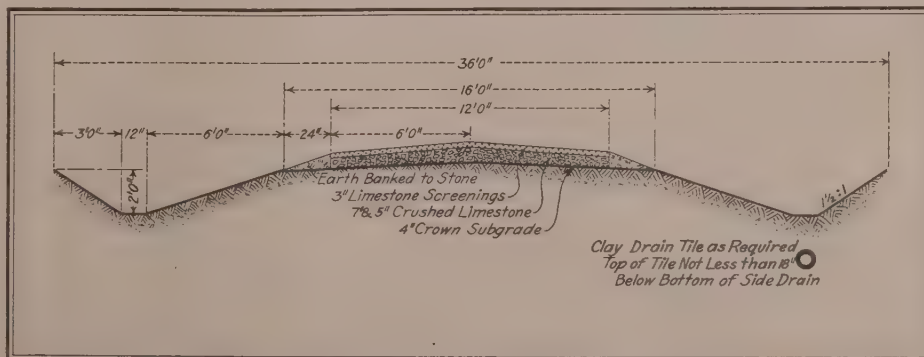
During the last two years the type here illustrated has been adopted. The subgrade, as shown in the drawing, can be built with the ordinary road grader pulled either by teams or farm tractor. Drainage is provided by clay drain tile laid in the center of the side drains. All tile drains crossing the road are replaced with cast-iron sewers, with brick receivers in the side drains. These receivers are laid up in cement mortar and equipped with removable cast-iron grates. Overflow sewers are of cast iron equipped with concrete bulkheads. All bridges and larger culverts are of reinforced concrete, and standard designs for those structures have been developed in the county engineer's office. After



NEWARK MEADOWS BREEDING PLACES CONTROLLED BY DIKES AND GATES

ment proved successful, and for several years the legislature appropriated sums of money to be used to demonstrate that class of drainage for mosquito-breeding elimination. The insufficiency of the method was due to the fact that in no one county could a large enough unit be drained to appreciably reduce mosquitoes, whose range of flight is several miles from the places where they breed. The result of this effort, says the commission, has proved that if the work could be extended on a larger scale much relief from mosquito nuisance would follow.

The Essex County Mosquito Extermination Commission began work early in the summer of 1912 with an appropriation of \$65,000, which represented a per-capita cost of 12½ cents. Prior to beginning work the state and city of Newark had cut 695,000 lin. ft. of ditches, which the mosquito commission took over as an asset. To this the commission added 450,000 ft. In 1913 the 350,000 ft. of new ditches cut completed the draining of the salt marshes under the commission's jurisdiction so far as it was possible to do so by open ditching. Observa-



COST OF ROAD OF THIS TYPE AVERAGES LESS THAN \$4,500 A MILE

the completion of the subgrade the surface is thoroughly rolled with a 10-ton roller until all settlement ceases.

#### ROAD REPAIRED WITHOUT USING NEW MATERIAL

Upon this subgrade a course of  $\frac{3}{4}$  to  $2\frac{1}{4}$ -in. crushed limestone, 5 in. thick at the sides and 7 in. thick at the center, is placed to a width of 12 ft. Limestone screenings ( $\frac{1}{4}$  to  $\frac{3}{4}$  in.) are then placed to a uniform depth of 3 in. and the metal thoroughly rolled. Ledger boards are used at the sides to hold the stone in place. Before they are removed earth is taken from the side drains and placed against them to hold the stone in place.

Under traffic the 12-ft. road spreads to 14 ft., and owing to shape of the finished road surface may be graded in and repaired without the use of new material.

Adams County has 25 miles of this type, including roads under construction, as a part of the county system of 500 miles of stone roads. Under ordinary conditions of traffic these roads will have a life of 15 to 20 years, with nominal maintenance charges.

The road shown in the photograph was built this year at a contract price of \$2,629.45. The estimates were as follows: 1321 yd. of stone complete in place, \$2,443.85; grading, \$350; sewers and headwalls, \$115; receivers and subdrainage sewers, \$42; tiling, \$15; concrete culvert (8 ft. span and 26 ft. long), \$322.50.

The total length of the road was 3800 ft., or 0.72 mile. Therefore the cost per mile would be from \$3,500 to \$4,500, depending on local conditions. All material was near at hand, and the longest haul was 2 miles. Common labor cost \$2 per 10-hour day and a team with driver \$4.50 per day.

### Test 9-Foot Masonry Conduit for Carrying Capacity

Results of Readings Continued for 48 Hours at St. Louis Tabulated in Annual Report to Water Commissioner

**D**URING February and March, 1916, tests were run on the 9-ft. masonry conduit between Baden and Bissell's Point, St. Louis, to determine its carrying capacity. This conduit, built in 1889, is horse-shoe in shape, 7 ft. 9 in. high and 9 ft. wide, with a granitoid finished invert and brick sides and arch. It was built with a uniform slope of 1 in 10,000 and discharges into the north, or No. 4, of the Bissell's Point storage basins. The following information is given in the annual report of Gordon G. Black, engineer in charge of the supply and purifying section, to E. E. Wall, water commissioner.

In testing, the discharge point, basin 4, was kept at a practically constant elevation, and hourly gage readings were taken at the Baden gate chamber, three gaging points between Baden and Bissell's Point, the terminal chamber and basin 4, all except that

at the terminal chamber being by hook gage. In maintaining basin 4 constant, the Bissell's Point pumps drew from that basin and the surplus passed over a weir of adjustable height into basins 3, 2 and 1, being measured there. Counter readings on the pumps (all triple expansion) and gage readings in the basins were taken hourly. Care was used to keep the amount of water filtered and sent through the large conduit at Baden as nearly equal to the quantity pumped at Baden during the hour, plus the quantity for which the 9-ft. conduit was to be tested, as could be. At the 80,000,000-gal. per day rate, readings were continued

through 48 hours, and at the 90,000,000-gal. rate through 36 hours, the first hours in each test during which readings were erratic being discarded in the final computations. The results are indicated in the table.

In computing *C* for the full section, the dimensions of the conduit as it was built were used; for the actual section the dimensions at present were used, these varying from the original dimensions because of the coating of lime carbonate on the sides. Near the bottom this is approximately  $1\frac{1}{2}$  in. thick, reducing to nothing at the water line.

## Letters to the Editor

*Comment on matters of interest to engineers and contractors will be welcomed*

### Information on Concrete Log Decks Desired

**SIR:** Can you through your columns give us any data concerning, or examples where, a concrete log deck has been used for unloading logs from cars into a mill pond? It is a question whether a concrete deck is flexible enough to withstand the impact imposed by falling logs, and any information concerning a concrete deck now in use will be appreciated.

G. L. COYLE,  
Engineer with Babcock Lumber & Land Company.  
Maryville, Tenn.

### Some Aspects of the Railroad Wage Controversy

**SIR:** I thank you for your editorial of Sept. 9, page 308, under the caption "Some Aspects of the Railroad Wage Controversy." I have been able, during the past four or five years, to talk with a few of the captains of industry and with more of the lieutenants. My interest in the question you discuss was first aroused because of the attitude of these men toward employees. They face a danger that they do not seem to recognize. They must discover some time that the balance of power lies in the hands of the men they employ and that sooner or later these men are to break away from party lines and support principles that will protect them. Compromise now might bring results that would be satisfactory to both employer and employee. A victory won at the polls by the laboring class may result in industrial revolution, and the employer will then discover, when too late, that he has been shortsighted.

If there is any profession, or any class of men, who should see the handwriting on the wall, it should be that of engineering. Our early training was, perhaps, unfortunate. We have lived in an age of special privilege. Our law-making bodies and, even more, our tribunals of justice have largely lost sight of the real interests of society in their haste to favor and protect private property. If the history of the labor party in other countries is to be repeated here, we have nothing to fear. Australia affords us an illuminating example. In that commonwealth the technicalities of law have largely been replaced by statutes based on live principles that all can understand and appreciate. Australia af-

fords the best model in government thus far produced. The engineers of the United States can perform no greater service for their country and for their profession than to accept the sentiments expressed in your editorial.

CLARENCE T. JOHNSTON.  
Ann Arbor, Mich.

### Final Report of Construction of Los Angeles Aqueduct

**SIR:** By a change in plan, the Board of Public Service Commissioners of the city of Los Angeles has made possible the acquirement of a copy of "The Final Report on the Construction of the Los Angeles Aqueduct" by those who failed to send a paid order for the volume previous to July 15. The board originally intended to print only the number of copies for which paid subscriptions were received to that date. Orders came in such volume, however, from all over the civilized world, that it was felt that when the book was published and in the hands of readers even a greater demand would be created. A new contract was therefore entered into for an additional 3000 copies, and so long as these last the volume will be delivered post paid in the United States or Canada for the regular subscription price of \$1.95. Subscriptions should be addressed to the Los Angeles Department of Public Service, 645 South Olive Street, Los Angeles, Cal.

Delivery of subscribers' orders has been delayed by the unexpected volume received and the changes necessitated in printing; but the copies should be in the hands of purchasers soon after this appears.

As now coming from the press, the book is a handsomely bound volume in green cloth library binding,  $8\frac{1}{2} \times 11$  in. in size comprising 336 pages, 110,000 words, and 62 full-page and 30 half-page engravings, besides 40 plates showing full engineering details of all features of this great work.

The city of Los Angeles realizes no profit on sales, the rather unique plan of selling a municipal report having been devised in order that the valuable volume, which is sold at less than cost, might be placed within reach of the many who could not hope to obtain a copy under the usual procedure of issuing reports of such character.

R. F. DEL VALLE,  
President, Board of Public Service Commissioners.  
Los Angeles.

#### DATA DETERMINED BY TESTS

|                                             |        |        |
|---------------------------------------------|--------|--------|
| Nominal rate, million gallons daily         | 80     | 90     |
| Average rate                                | 82.58  | 91.21  |
| Number of hours averaged                    | 9      | 8      |
| Gage 1 at Baden gate chamber                | 110.60 | 110.93 |
| Gage 2 at terminal chamber                  | 107.32 | 106.48 |
| Gage 3 at Basin 4                           | 106.99 | 106.00 |
| Distance between gages 1 and 2, ft.         | 17.044 |        |
| <i>C</i> in Chezy formula (full section)    | 119.8  | 118.5  |
| <i>C</i> in Chezy formula (actual section)  | 121.4  | 119.8  |
| Velocity, average at Baden, feet per second | 2.42   | 2.60   |
| Velocity, average, at outlet                | 3.07   | 4.27   |

# HINTS FOR THE CONTRACTOR

## Details Which Save Time and Labor on Construction Work

*Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents*

### Rock Ballast for Industrial Track Pays on Road Work

By HARLAN H. EDWARDS  
Urbana, Illinois

USING SOME of the macadam stone for ballasting the 2-ft. gage industrial track employed on the road work near Hoopston, Ill., described on page 400 of the Engineering Record for Sept. 30, 1916, was found to be well worth while. At first the track had been laid along the earth shoulders of the road, but after every rain

*Contributions to this section are solicited, and if found available will be paid for. They must be SHORT, and should be accompanied, if possible, by photographs or sketches.*

8 to 14 ft., the concrete portion extending to El. —0.5 and the remainder of the piers being constructed of granite. The excavation for each pier was made with a ½-yd. grab bucket handled by a small power derrick. The forms set in these excavated pockets were made of 2 x 6-in. tongue-and-

pipe was used, suspended from the frame by two 3-ton differential hand tackles, by which it could be easily and rapidly raised when full of concrete. The fixed hopper, which was above the small circular hopper secured to the top of the tremie pipe, had a capacity in excess of the entire pipe. In this way sufficient concrete completely to fill the tremie pipe could be placed in the large hopper before opening the gate under it when starting to concrete a pier. This was necessary, as the bucket handled by the boom on the pile driver carried only 9



RAINS AND HOT WEATHER WASHED OUT AND TWISTED INDUSTRIAL TRACK ON ROAD WORK TILL TROUBLE WAS OVERCOME BY USING BALLAST

it settled in spots, while on hot days the rails expanded and twisted the track over the entire roadway. Much expense for maintenance was occasioned, and there was frequent danger of derailment. The accompanying photographs show clearly the way in which the track behaved when laid directly on the shoulder and the improvement made by using the ballast.

### Unique Tremie Float and Driver Rigger as Derrick Used by Navy

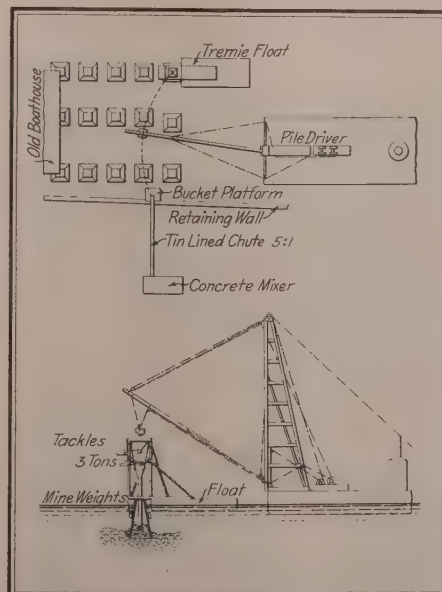
PLANT ALREADY on hand was converted through the ingenuity of civil engineers of the United States Navy to construct fourteen concrete piers under water for an extension to the boathouse at the Newport, R. I., naval training station. Concrete for these footings was conveyed from the mixer by chute to a bucket at the water's edge, handled by an improvised boom mounted on a floating pile driver to a hopper supported on a small barge, and deposited through a tremie in wooden forms weighted down in place in the dredged excavations made for each pier. The work, including the superstructure, was done in this way for \$6,450, a little less than the appropriation available and more than \$4,000 less than the lowest bid received for the work. The method was developed after cofferdam work had been found to entail the use of expensive plant which could not be provided within the appropriation. The work is described by Civil Engineer Kirby Smith in a recent issue of *Public Works of the Navy*.

The twelve piers ranged in height from

groove plank with 4 x 4-in. corner braces, which extended about 6 in. below the form proper. After placing, dredged material was filled around the lower part of each form to hold it in place and seal the bottom. Also eight 90-lb. lead mine weights were hung outside the forms to overcome buoyancy. A fixed hopper and a frame for handling the tremie were carried on one end of a 15 x 30-ft. steel float. A 15-in.

cu. ft. The bottom of the pipe was kept embedded 12 in. in the concrete, and only once was the concrete in the pipe lost. The tremie had to be watched closely, however, as with the release of weight in discharging concrete from the upper hopper the small float would rise rapidly, carrying the tremie with it.

The concrete was conveyed from the ½-yd. gasoline-driven Austin mixer on the bank to the bucket on the lower platform through a tin-lined wood chute. Although the flow was regulated at the mixer, the lower end of the chute was fitted with a sliding gate and the sides increased in height to 24 in. to prevent loss of concrete. As the work could only be prosecuted at favorable stages of the tide, a progress of two piers a day was considered good. The 109 yd. of concrete placed in this way cost \$9.91 per cubic yard and the entire footing work, including the excavation, forms, concrete and granite, cost \$2,142.81.

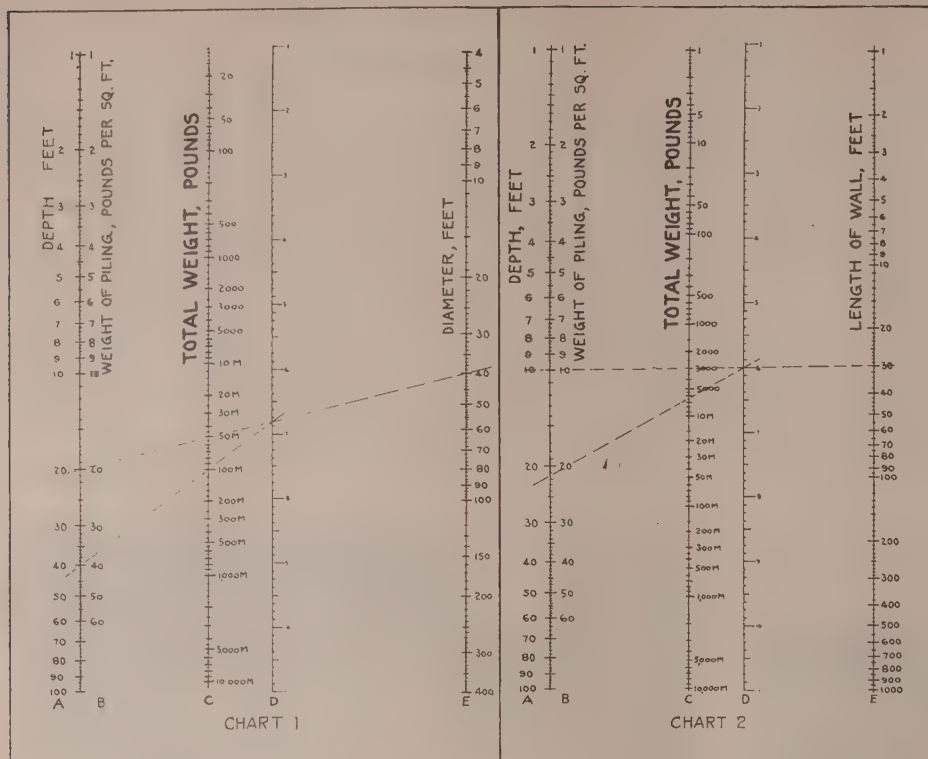


CLEVERLY CONVERTED PLANT ENABLED NAVAL ENGINEERS TO BUILD UNDERWATER FOOTINGS WITHIN APPROPRIATION

### Charts Tell Weight of Sheeting for Round or Box Cofferdams

By N. G. NEAR  
New York City

THE NOMOGRAPHIC charts reproduced herewith have been found to save considerable time in calculating the quantity of steel sheeting required for a given wall or cofferdam, especially in the case of a circular structure. Chart No. 1 is for computing the weight of such cofferdams, and its use may be illustrated by supposing that it is desired to find the weight of steel



TWO MOTIONS WITH A STRAIGHT EDGE DETERMINE WEIGHT OF SHEETING FOR COFFERDAM

sheet piling required to construct a cofferdam 40 ft. in diameter and 20 ft. deep, assuming that a section weighing 40 lb. to the square foot is used. To solve this problem, connect 20 on scale A with 40 on scale E and locate the intersection with scale D. Connect the point thus found with 40 on column B. The weight, 100,000 lb., is then read at the intersection of this last line with column C.

The second chart, which is for straight-wall or irregular structures where the total length is known, is used in a similar manner. For example, to find the weight of steel sheeting required to build a wall 30 ft. long and 10 ft. deep, using a section which weighs 21.5 lb. per square foot, connect 10 on scale A with 30 on scale E, locate the intersection with scale D and

connect this point with 21.5 on scale B. The total weight, about 6500 lb., is read at the intersection of this line with scale C.

The range of these charts is wide enough to cover almost any sheet-pile structure. The weight per square foot of the type sheeting which is to be used can, of course, be taken from the handbooks of the steel companies which make piling.

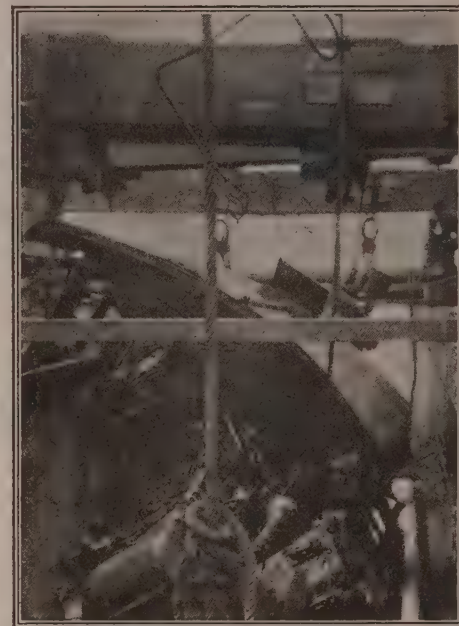
### Locomotive Raised from Harbor by Jacks Mounted on Scows

By VICTOR W. KILLICK  
Glendale, Cal.

**A** RAILROAD locomotive was recently raised from the bottom of the harbor at San Pedro, Cal., by being jacked up between

two barges, floated at high tide over a temporary track built on a nearby mud flat and lowered once more to the rails. The jacks were set under the ends of built-up timber girders which spanned between the barges and from which the locomotive was slung. Three lifts were necessary to bring it to the surface.

The engine, which had been handling a large pile driver used in repairing a railroad trestle in the harbor, reached the bottom of the bay through the collapse of the portion of the old trestle on which it had been standing. It turned over in falling and landed in soft mud about 30 ft. below the surface. It was not desirable to attempt raising the locomotive to the trestle with a wrecking crane, and no floating cranes of sufficient size were available in the harbor. Two 200-ton barges were therefore secured and placed side by side over the wreck 12 ft. apart. They were fastened together at each end with two girders made up of three 20-ft. piles each, lashed together with heavy manila rope, each turn of which was drawn tight with a hoisting engine. For raising the locomotive three heavy clusters of timbers, one at each end



LOCOMOTIVE WAS CARRIED OVER TRACK ON MUD FLATS AT HIGH TIDE



HEAVY TIMBER GIRDER FROM WHICH LOCOMOTIVE WAS SLUNG WERE JACKED UP TO SURFACE ON CRIBWORK, THREE OPERATIONS BEING REQUIRED

and one in the center, were placed across the gap between the barges. Under each end of each of these girders was placed a 50-ton hydraulic jack, and 1¼-in. steel cables were used to suspend the locomotive. After the engine and tender were turned right side up, hoisting was begun, using the usual method of supporting the timber girders on cribwork while the jacks were reset. When the locomotive had been raised about 10 ft. in this way it was slung from the barges by a second set of cables, while the timber girders were lowered again to the deck. After this operation had been repeated three times, the locomotive had been raised high enough to permit its being towed to the mud flats mentioned, half a mile above the trestle, and replaced on the temporary track, which had been built at low tide.

The services of a diver were required during the operations to remove several broken piles at the site and to fasten the cables to the locomotive.

# NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

## Fire Wrecks Bridge Over Missouri River

**\$500,000 Structure May Be Total Loss—Eastern Approach Demolished—Spark from Locomotive Starts Blaze**

Most of the timber floor and all of the timber trestle of the eastern approach to the St. Charles (Mo.) highway bridge across the Missouri River was destroyed by fire Sept. 26. The steel work of the bridge, which consists of four through-truss spans—three of which are 460 ft. and one 360 ft. long—and one deck-truss span about 250 ft. long, was badly damaged.

The entire floor system appears to be ruined. Numerous panels of eyebars in the bottom chords of the through trusses have been lengthened by the intense heat and several vertical and diagonal members of the trusses are practically sheared in two. The deck-truss span is so badly warped and twisted that it is doubtful whether any parts of it can be used in reconstruction. The floorbeam at the west, or expansion, end of this span buckled so badly that the connection of the south truss to its shoe was severed and the truss pulled about 2 ft. out of line. This action also drew the shoes at the east end of the span about 5 or 6 in. out of position and chipped several large blocks of concrete off the top of the pier. The laterals and swaybracing of this span are also badly distorted.

### Eastern Approach Total Loss

The entire eastern approach, a timber trestle about 500 ft. long resting on concrete footings, is a total loss. The floor of the bridge, which carried one street-railway track and a roadway, was of timber construction, with stringers resting on the steel floorbeams. It was covered with a two-ply floor of 3-in. material, the first ply of which was creosoted pine and the top of oak. The fire, which started about midway of the west span, is supposed to have been caused by a spark from a locomotive which was doing some switching about 200 ft. west of the point of origin. When first brought to the watchman's attention a very small area of the under side of the floor was burning. The local fire department was immediately notified, but by the time they had arrived a high wind had whipped the fire into a roaring conflagration. Fire-fighting apparatus sent from St. Louis in an attempt to save the eastern approach and several small residences was unable to stay the flames.

### Original Cost \$500,000

The bridge was designed by and built under the supervision of Waddell & Hedrick, consulting engineers, of Kansas City. The Missouri Valley Bridge & Iron Company was the contractor for the substructure and the Midland Bridge Company for the superstructure. Mr. Hedrick has been retained by the owners to make a thorough examination as the structure now stands and an estimate of the necessary expenditure to reconstruct it. The original cost was about \$500,000. W. V. Delahunt, secretary of the Commonwealth Trust Company, owner of the bridge, stated that it had not yet been decided whether the structure would be rebuilt.

This information was furnished by A. R. Ross, engineer in charge of the St. Louis Municipal Bridge.

## Will Build About 1000 Miles of Railroad in China

**American Capital Finances Work—Probable Cost Will Run Into Millions—\$500,000 for Preliminary Survey**

A contract for the location and construction of about 1000 miles of railroad in China was signed Sept. 30 by the Chinese government with the Siems-Carey Railway & Canal Company, in which firm the American International Corporation is financially interested. According to the first announcement on Oct. 3 the necessary funds will be raised by a Chinese bond issue to be marketed by the American International Corporation. Reports that the probable cost will be \$50,000,000 or more are unconfirmed by the corporation, as nothing like a definite figure can be agreed upon until the lines are located and the nature of the construction determined.

### American Engineer to Have Charge

According to a statement by Willard Straight, vice-president of the American International Corporation, the lines will be located by an American chief engineer who will later, on behalf of the Chinese government, superintend the construction. He will, upon the road's completion, act as its chief engineer. An American auditor and a traffic manager will also be appointed. No routes have yet been selected, although \$500,000 has already been advanced to cover the cost of investigations and surveys. At present there are only about 6000 miles of railroad in China. The construction of the new lines, on which actual work will start in about a year, will therefore almost triple that country's railroad mileage.

### May Build Canals

Siems and Carey are railway contractors of St. Paul. Last May they signed a preliminary agreement with the Chinese government for the construction of railroads in China. About the same time preliminary contracts for dredging the Grand Canal were concluded and the American International Corporation, together with the Siems-Carey Company, organized the Siems-Carey Railway & Canal Company, to undertake the construction of railroads and the dredging of the canal. Final agreements for the canal work are now under negotiation. The announcement in the Engineering Record of Aug. 12 of the appointment of F. C. Hitchcock, formerly vice-president of the MacArthur Brothers Company, to a similar position with the Siems-Carey organization in China indicates that possibly he is the American engineer who will have charge of the work. The new contract will be handled on a percentage basis.

## City Managers Will Meet at Springfield, Mass.

The annual convention of the City Managers' Association will be held Nov. 21 to 23 at Springfield, Mass. Although the tentative arrangements include no presentation of papers, the program provides for discussion by each member of the topics which have been selected. The convention will really be opened at Springfield, but those who desire to inspect New York City's municipal activities will meet in that city Nov. 20, leaving for Massachusetts that night. The following three days will be devoted to three or five-minute discussions by each member on topics relating to the duties of the city manager and matters bearing on the improvement of that form of government.

## Discuss Civic Organization of Engineers and Chemists

**Proposal Made That Naval Consulting Board's Industrial Preparedness Committee Be Made the Nucleus**

Shall the engineers and chemists of the country form an organization for the consideration of, and action on, public questions of an engineering nature?

This was the question put before a gathering of engineers called together at luncheon at New York on Sept. 28 by W. L. Saunders, past president of the American Institute of Mining Engineers and a member of the Naval Consulting Board. The governing thought, Mr. Saunders explained, was whether, since an organization of engineers for civic work had been created by the Naval Consulting Board through its committee on industrial preparedness, it is not wise to hold the organization together and to make it permanent. Such problems as the conservation of our natural resources, mining laws, railroad regulation, and river and harbor appropriations might be considered. Mr. Saunders proposed that the new organization be independent of the national engineering and chemical societies, but that the qualification for membership in the new body would be membership in the existing national professional organizations.

### Vote to Appoint Committee

A general discussion followed Mr. Saunders' statement. Most of the speakers believed that the national engineering and chemical societies would not be inclined to take suitable action on civic questions, and therefore favored the perpetuation of the Naval Consulting Board's organization. It was pointed out, however, that the existing bodies are well organized and have the necessary machinery for effective action. On one point there was unanimity—that there should be some agency by which the engineers and chemists could exercise an influence in public life. There was a difference of opinion only on what the agency should be.

As a result of the discussion it was voted that the chairman should appoint a committee of five to consider the question from the various angles brought out in the discussion and to report conclusions at a later meeting. Mr. Saunders is to be an ex officio member of the committee.

### Personnel of Committee

The committee, as appointed by the chairman, is as follows: J. J. Carty, past president of the American Institute of Electrical Engineers; Charles Warren Hunt, secretary, American Society of Civil Engineers; Calvin W. Rice, secretary, American Society of Mechanical Engineers; Thomas Robins, member of the Institute of Mining Engineers; Benjamin B. Thayer, director, the Engineering Foundation.

Among those present were Clemens Herschel, president, American Society of Civil Engineers; H. W. Buck, president, American Institute of Electrical Engineers; D. S. Jacobus, president, American Society of Mechanical Engineers; Dr. Charles H. Herty, president, American Chemical Society; Gano Dunn, chairman, the Engineering Foundation; Frank J. Sprague, past president, American Institute of Electrical Engineers; Dr. L. H. Baekeland, past president, American Electrochemical Society, and E. J. Mehren, editor, Engineering Record.

Information has just been received that on Aug. 25 a resolution was adopted by the Affiliated Technical Societies of the City of Atlanta urging similar co-operation in civic activities.

## Prices of Materials This Week

See Page 149

## Four-Day Smoke Convention at St. Louis

Standards Presented and Every Phase of Combustion Discussed—Firing of Locomotives Demonstrated

The Smoke Prevention Association held its annual convention at the Planters Hotel, St. Louis, Sept. 26 to 29, with an attendance of 86. The first session was opened Tuesday morning by President W. A. Hoffman. C. H. Daues, city counselor, gave the address of welcome and W. M. Chauvenet spoke in behalf of the Joint Smoke Prevention Committees of St. Louis.

An important feature of the morning session was the report of the standardization committee. The composite report by each of the twelve members covered practically the entire field of the smoke inspector. In the first of the individual reports a violation was defined and standard permit and certificate of operation clauses were suggested. Other standards were presented, but their use discouraged.

A report on front-feed stokers showed standard methods of setting this furnace with different types of boilers. Another section dealt with standard methods of applying chain grates to different types of water-tube boilers. A report on locomotive practice suggested standard methods of firing in service, of building up the fire, and of applying brick arches and steam jets. These various standards will be given a year's trial before they are officially adopted.

### Heating Plants Deserve Study

In the first paper of the afternoon session, by O. Monnett of Chicago, it was pointed out that smoke from heating boilers was much more detrimental than that from high-pressure plants, due to the presence of tarry matter and unignited distilled creosote passing off at relatively low temperatures. Besides damaging buildings and vegetation these products often cause acute lung diseases, so that it is of the greatest importance to give more attention to the study and regulation of heating plants. W. A. Pittsford of Chicago traced the evolution of arch buildings over chain grates during the last 12 years and suggested a standard setting.

Wednesday morning J. W. Henderson, chief of the Bureau of Smoke Prevention in Pittsburgh, told of the progress made in that city, where publicity had proved most effective in securing public interest and co-operation. "Chimney Draft and Its Relation to Boiler and Furnace Efficiency" was the title of the next paper, by E. R. Fish of the Heine Safety Boiler Company. The speaker outlined the advantages of natural draft and the use of forced and induced draft for high rates of combustion.

### Thursday Was Railroad Day

At a short afternoon session Joseph G. Worker pointed out that all large central stations now operate with very little smoke and that the proper use of instruments has been a great factor in obtaining present-day economy. He said that high efficiency at normal rating with a wide range of operation and large reserve capacity was the prime factor of the under-feed stoker rather than large steaming capacity.

Wednesday evening's entertainment was supplied by the Engineers' Club and the Associated Engineering Societies of St. Louis, as noted in last week's issue. Thursday was railroad day. The entire morning was devoted to papers on problems met in locomotive operation. Practical demonstrations of firing up engines were given in the afternoon.

The principles of combustion and the cause of smoke formation were discussed Friday, as was the importance of fineness and intermingling of the coal with the air supply. This was followed by an outline of the Bruden method of burning powdered coal.

Officers elected for the ensuing year were: W. H. Reid, president; Martin Rooney, first

vice-president; W. L. Robinson, second vice-president, and A. A. Chambers, secretary-treasurer. Columbus, Ohio, was chosen as the place for the next convention.

## Two Killed, Thirty Hurt in Cleveland Bridge Failure

Two cars crashing together the night of Oct. 3 on the Third Street bridge, Cleveland, caused that steel structure to collapse and precipitate its load upon the tracks of the Baltimore & Ohio Railroad 30 ft. below. The cars almost rolled into the Cuyahoga River. Of the approximately sixty occupants of the two cars, two are reported killed and thirty injured.

The motorman lost control of his heavily loaded car on a hill. The runaway conveyance reached the north approach to the bridge at the same time as a car coming from the opposite direction. The two cars crashed together, and their combined weight, together with the shock of the collision, caused the old structure to sag and then give way.

The portion of the bridge which fell is just north of the river. The structure was erected in 1888 and has a span of about 105 ft. The opinion has been advanced that while the structure is about 28 years old a newer bridge could not have withstood the impact such as the two posts received.

## Propose Law to Prevent Public Bidding on Municipal Work at Los Angeles

An organization intended for civic betterment, known as the United Improvement Federation, has drafted a drastic measure in an attempt to eliminate public contracting from the field of local municipal improvements at Los Angeles. The proposed amendment to the city charter makes unlawful the calling for any bids for street, sewer, water and similar city improvements and extensions. It proposes that such work be handled at actual cost by a municipal department organized and operated particularly for such purpose. Arranged in the form of a petition for property owners' approval for formal presentation to the city council and submission at a special election this month for the ratification of voters, the amendment reads as follows:

"No contract for the grading, regrading, paving, repaving, macadamizing, remacadamizing, construction of sewers or construction of sidewalks shall be entered into by the City of Los Angeles.

"This charter amendment to provide for the improvement by the direct employment of labor, purchase of material, of the streets, avenues, alleys, or other public places of the city, or for the construction or reconstruction in any public street, avenue, alley or other public place in the city, or in any right-of-way owned by the city, of sewers, drains, water and gas mains, lines and conduits for transmitting electric energy or telephone communication, and to make the cost thereof a lien and charge upon abutting property or upon property in the districts according to benefits.

"The foregoing charter provision and all ordinances, acts and procedure enacted, done or taken in pursuance thereof shall be valid and binding, anything in any law of the state heretofore or hereafter to the contrary notwithstanding."

## Brooklyn-Brighton Bridge Opened September 30

The official opening of the Brooklyn-Brighton bridge at Cleveland was celebrated Sept. 30. As described in the Engineering Record of June 24, page 832, the structure has many features of unusual interest, among which are the use of unsymmetrical arch spans, necessitating unequal levels of springing lines. The total length of the bridge is about 1726 ft. It is made up of eighteen arch spans, six of which are of 139-ft. span.

## Fellowship Established for Asphaltic Research

With the co-operation of Harvard University and the Massachusetts Institute of Technology, the Barber Asphalt Paving Company has established at these institutions a fellowship for research in asphaltic materials and their uses. The fellowship is to be known as "The Clifford Richardson Fellowship." Mr. Richardson, an alumnus of Harvard, has made many contributions to asphaltic highway construction and to the chemistry of bitumens.

The appointment of the incumbent of the fellowship and the choice of subjects for investigation, as well as the disposition to be made of the results of such investigations as may be undertaken, are to be decided by the institute faculty or the joint committees of the university and the institute having control of engineering work.

## Hearing on Official Plan of Miami Conservancy District Last Tuesday

A hearing before the conservancy court at Dayton on the official plan of the Miami Conservancy District began last Tuesday. The program is that submitted to the district by Arthur E. Morgan, president of the Morgan Engineering Companies, and adopted by the board of directors May 10, 1916.

The hearing is of considerable interest and importance in that it deals with a flood-control project, the plans for which are to be tested before a court of nine judges acting under a new law, and by the examination of a number of consulting engineers.

It is expected that the close examination of this plan before the court will bring out the most complete and comprehensive compilation of data and discussion relating to a single flood-control project that has ever been developed.

## Street-Cleaning and Refuse-Disposal Society Meets October 13

The second annual convention of the Society for Street Cleaning and Refuse Disposal of the United States and Canada will be held Oct. 13 and 14 in New York City. As announced in the Sept. 2 issue, the sessions will be held in the offices of the New York Department of Street Cleaning. The program includes papers on all methods of collecting dirt. An appropriate motion picture entitled "The Day's Work," will be shown by the Gaumont Film Company.

## Prizes for Photographs Showing Merits of Concrete

Cash prizes for photographs illustrating the uses of concrete will soon be offered by the editorial bureau of the Portland Cement Association. In addition, all prints having a distinct value for advertising purposes will be purchased. Arrangements for the competition, which is open to all, are now under way. Further particulars may be obtained from the Portland Cement Association, 111 Washington Street, Chicago.

## Would Build Transcontinental Highway in Canada

The Military Hospitals Commission, at its recent meeting in Toronto, passed resolutions to be forwarded to the government calling for the construction of a transcontinental road which would be modeled after the Lincoln Highway. The resolution calling for the construction of a national highway points out that work would be provided for thousands of unskilled men and for ex-soldiers returning after the war who could not otherwise find work at once.

## Sanitarians Visit Electrolytic-Lime Sewage Plant

Nearly 100 men, including stockyard and industrial chemists, city officials, capitalists and sanitary engineers, on Sept. 30, at the invitation of the Electrolytic Sanitation Company, visited the 1,000,000-gal. experimental electrolytic-lime sewage-treatment plant at Decatur, Ill. The plant, which is similar to the one at Elmhurst, L. I. (see Engineering Record Sept. 12, 1914, page 292; Sept. 19, page 315 and Oct. 17, page 429), consists of an electrolytic machine in which the sewage remains one minute, a lime-charging outfit, a hopper-bottom settling basin of  $\frac{1}{2}$ -hour capacity, and a Johnson sludge press. The machine contains twenty-two banks of electrodes consisting of forty-eight 10 x 16-in. iron plates  $\frac{3}{16}$  in. thick. The plates are  $\frac{3}{8}$  in. apart, and between each plate are two revolving paddles which agitate the sewage and keep the surfaces of the plates clean without touching them.

Current is supplied at a constant rate of 40 volts and 70 amperes. To turn the paddles requires 1200 watts. The average lime applied for the official test period of one month was 2846 lb. per 1,000,000 gal. The resulting sludge amounted to  $4\frac{1}{2}$  tons dry, in which it is claimed there are from \$5 to \$8.79 worth of fertilizer values per ton. The 4,000,000 gal. of sewage from the city of 45,000 people contains 750,000 gal. per day of waste from a starch factory, which has in it a large amount of sulphurous acid. The average suspended matter was 467 parts per 1,000,000.

### The Effluent

The effluent, as described in a leaflet furnished by the company, "has a yellow color and a slight odor peculiar to the waste and to lime, but it is not disagreeable. The color is due to the action of the excess of lime on the protein content of the waste. The effluent containing this starch waste is not stable in the ordinary accepted terms, but when exposed to the air it does not become offensive or putrid, and loses its odor in a few days. When the starch waste is absent, or is highly diluted, the stability test by methylene blue shows a stability of 100."

After settling for one hour the bacterial and suspended matter removal was reported to be slightly more than 95 per cent in both cases. Comparative results on one-half and one-hour periods of sedimentation in the nitrogen content are shown in the table:

COMPARATIVE RESULTS

|                      | $\frac{1}{2}$ -hour |    | Period | Per cent of raw sewage |
|----------------------|---------------------|----|--------|------------------------|
|                      | P.M.                | M. |        |                        |
| Free ammonia.....    | 9.28                |    | 51     | reduction              |
| Nitrates.....        | 0.188               |    | 269    | increase               |
| Nitrates.....        | 0.999               |    | 97     | increase               |
| Total organic.....   | 65.4                |    | 14     | reduction              |
| Oxygen consumed..... | 331.8               |    | 16     | reduction              |

|                      | 1-hour period |    | Period | Per cent of raw sewage |
|----------------------|---------------|----|--------|------------------------|
|                      | P.M.          | M. |        |                        |
| Free ammonia.....    | 11.3          |    | 43     | reduction              |
| Nitrates.....        | 0.234         |    | 333    | increase               |
| Nitrates.....        | 1.06          |    | 63     | increase               |
| Total organic.....   | 62            |    | 23     | reduction              |
| Oxygen consumed..... | 383.8         |    | 19     | reduction              |

No results of stability were reported by the biochemical method and no results were given showing what the plant would do were the same amount of lime whipped into the sewage without the electric current.

## Waterworks Men Will Open Joint Convention Next Week

The joint meeting of the Iowa and Illinois sections of the American Waterworks Association Oct. 11 will be preceded by a one-day convention of the Iowa division in the Hotel Blackhawk, Davenport, Iowa. The morning of Oct. 10 will be devoted to a round-table discussion by the Iowa members of problems relating to satisfaction of water consumers, leaks in river crossings, cleaning of water

mains and pumping economy in small plants.

A paper on an inverted siphon in a suction line, by Karl C. Kastberg, city engineer of Des Moines, will be presented at the afternoon session. J. H. Dunlap, professor of hydraulics and sanitary engineering at the State University of Iowa, will speak on "The Sanitary Drinking Fountain." J. M. Lewis, commissioner of waterworks and parks, will speak about the Sioux City booster station, and Earl T. Kirkpatrick, of the Des Moines Water Company, will tell of his company's experience in handling bad-water complaints. The purification of the Missouri River water is the subject on which J. B. Thornell, of the Council Bluffs waterworks, will address the meeting. Papers on swimming-pool operations and the

## Tentative Program for Irrigation Congress Arranged

A tentative program has been arranged for the twenty-third International Irrigation Congress, to be held Oct. 14 to 19 at El Paso, Tex. The first day will witness the formal dedication of the Elephant Butte dam. The following Monday, which will be devoted to the appointment of committees, has been set aside as a special day in honor of governors of states and representatives of foreign countries. The irrigation-districts section will meet on the third day under the direction of A. L. Cowell, past secretary of the California Association of Irrigation Districts. Dr. John A. Widsote, president of the University of Utah,

## St. Louis Municipal Bridge Nears Completion

THE popular joke that St. Louis has the longest bridge in the world—"one without an end"—ceased to be a fact Friday, Sept. 22, when the last panel of girders connecting the eastern railway approach to the channel spans of the municipal bridge was set in place. There remain to be erected the highway portion of the eastern combined approach and approximately  $1\frac{1}{2}$  miles of the eastern railway approach, including one 184 $\frac{1}{2}$ -ft. and one 227 ft. 3-in. span. It is expected to have all foundation work finished before cold weather. The concrete base for the roadway paving is complete on the west approach and the channel spans. Also, on the west approach, the sidewalks are in place and the wood block paving is well under way. The concrete base for the paving of the roadway on the east approach is progressing rapidly.

The work is being done by the city of St. Louis under the direction of Clinton H. Fisk, chief engineer of construction, Board of Public Service, and William F. Collier, general superintendent. Boller, Hodge & Baird of New York City are the consulting engineers, and Brenneke & Fay of St. Louis are resident engineers. A. R. Ross, engineer in charge, furnished the information and photographs. A description of the job appeared in the Engineering Record of June 10, 1916, page 760.



Tri-City water plant are scheduled for presentation in the evening.

The Iowa men will join the Illinois section Wednesday at the filter plant of the Rock Island arsenal, following which an inspection will be made of pumping stations and filter plants in the vicinity. At the dinner to be held that evening in Moline Leonard Metcalf, president of the American Waterworks Association, and Mayor Martin R. Carlson will address the convention.

## \$100 for Best Letter on Use of Hydrated Lime

For the best letter on the use of hydrated lime in concrete construction \$100 will be paid; for the two next best letters, prizes of \$50 and \$25 are offered by the National Lime Manufacturers' Association. All letters not returned to their authors will be paid for at the rate of \$5.

The problem consists of writing a 500-word (or less) letter on the use of hydrated lime in some specific concrete operation. Photographs are desirable, but not necessary. All letters are to be signed and mailed to reach E. J. Mehren, editor of the Engineering Record, by Dec. 6. Further details can be obtained from the hydrated-lime bureau of the National Lime Manufacturers' Association, Arrott Building, Pittsburgh.

will preside at the session of the irrigation-practice section. That afternoon and evening will be devoted to "rural credits and land settlement" and a conference between water users and representatives of the U. S. Reclamation Service.

The sessions of the members interested in irrigation legislation and drainage and irrigation engineering will be held Wednesday.

## Chicago Cement Show Will Be Held February 7 to 15, 1917

Feb. 7, 1917, has been selected as the opening date of the tenth Chicago cement show, which will be housed in the Coliseum and annex. Several conventions to be held in Chicago at approximately the time of the cement show give promise of that city being the center of activity of the building industry in February. As only the Coliseum and annex will be used, the exhibits will be more concentrated. Exhibitors are asked to apply early for the smallest space in which they can display their materials.

The National Builders' Supply Association, Illinois Lumber & Builders' Supply Dealers' Association, American Pipe & Tile Association, American Concrete Institute and American Association of Engineers are among those that will probably convene in Chicago early in February.

## Engineering Society Activities

At the American Society of Civil Engineers' Oct. 18 meeting, a paper by J. B. Lippincott, consulting hydraulic engineer, of Los Angeles, on "A Method of Determining a Reasonable Service Rate for Municipally Owned Public Utilities" will be presented for discussion.

The Detroit Engineering Society will hold a meeting Oct. 20, at which Frank B. Gilbreth, expert on management and time-study work, will give an illustrated lecture on those subjects. Last evening the society heard C. W. Hubbel discuss sewage disposal and contamination of the Detroit River.

The Oregon Society of Engineers recently entertained as its guest A. N. Johnson, formerly of the Illinois State Highway Commission and now chairman of the New York Municipal Bureau of Research. Mr. Johnson addressed the club on road work and legislation.

The Committee on Engineering Co-operation at the second annual conference held in Chicago last April adopted a resolution providing for a sub-committee composed of four men selected by the chairman to act with him in the preparation of a plan to be submitted for consideration at a third conference called for the purpose. Conforming to the instructions in this resolution, F. H. Newell, chairman of the committee, has named Hunter McDonald, Isham Randolph, M. L. Cooke and C. E. Drayer as members. A first draft of a plan is in the hands of the sub-committee, which will probably meet during the next month for further consideration of it.

The Colorado Association of Members of the American Society of Civil Engineers will hold a joint meeting this evening with local sections of the American electrical and mechanical engineering societies. Westinghouse steam railroad electrifications of several large railroads will be described and illustrated by motion pictures. S. G. Porter, secretary of the Calgary branch of the Canadian Society of Civil Engineers, will discuss irrigation development in Western Canada.

## What Engineers and Contractors Are Doing

J. W. EVANS, who for the last three years has been employed by the bureau of lands of the Philippine government, was recently appointed instructor in the civil-engineering department of the Oklahoma Agricultural and Mechanical College. That institution is broadening the scope of its engineering courses and increased attendance has necessitated additions to the faculty. Mr. Evans' work in the Philippines was in the execution of cadastral surveys in the province of Occidental Negros.

ALBERT L. UPHAM has resigned from the employ of the Dunn-McCarthy Company, contractors, of Chicago, to become inspector for the Indiana Concrete Roads Association, with office at Bloomington, Ind. Previous to his employment by the Dunn-McCarthy Company Mr. Upham was with the Cuban Portland Cement Company.

G. W. STICKNEY, formerly in charge of designs in the paving department of the bureau of engineering of Syracuse, N. Y., has been appointed chief engineer for the Rivers and Lakes Commission of Illinois, with headquarters at Chicago. After graduation from the University of Maine in 1900 he was employed by the J. W. Bishop Company for about a year, following which he entered the employ of the Metropolitan Water and Sewage Board of Boston. During his service with the board Mr. Stickney took part in the work of constructing the Wachusett dam at Clinton, Mass. From

1904 to 1915 he was engaged on New York State Barge Canal work as leveler, assistant engineer and resident engineer. He resigned in 1915 to enter the bureau of engineering of Syracuse, N. Y.

IRA B. LANPHIER has left the employ of the maintenance-of-way department of the Illinois Central Railroad to become assistant in the civil-engineering department of the University of New Mexico. Mr. Lanphier was graduated from South Dakota State College in 1915 and received his C.E. degree this year. He has spent his time since then in the employ of the Illinois Central. Several buildings are now under construction at the university, he says, whose architectural design has, for the sake of economy and general artistic effect, been based on that of the Pueblo Indians.

PROF. A. B. MCDANIEL, whose resignation as assistant professor of civil engineering at the University of Illinois was briefly announced in the June 24 issue, has assumed his duties as assistant professor of civil engineering at Union College. Professor McDaniel was graduated from Massachusetts Institute of Technology in 1901, following which he was employed by the American Bridge Company. After about two years' experience as draftsman for several engineering companies he was in 1903 made structural engineer for the Fort Pitt Bridge Works. That was followed the next year by his appointment as assistant engineer on the East River division of the Pennsylvania Railroad tunnels at New York City. Two years later he first turned his attention to educational work as instructor in civil engineering at the Case School of Applied Science. He resigned the following year to become professor of civil engineering at the University of South Dakota, in which position he served for one year. During his residence in South Dakota Mr. McDaniel established the Missouri Valley Engineering Company, of which he was president from 1907 to 1912. From 1909 until last June he was a member of the faculty of the University of Illinois. He is the author of a book on "Excavating Machinery" and has contributed a number of articles to the engineering press.

JOHN S. CARPENTER, who has been with the Pelton Water Wheel Company as hydraulic engineer for the last eight years, is now designer of hydroelectric power plants for the Fargo Engineering Company, of Jackson, Mich.

HOWARD E. STEVENS, whose promotion from bridge engineer to chief engineer of the Northern Pacific Railway was noted in last week's issue, was graduated from the University of Maine in 1897. For two years thereafter he was employed by different bridge companies, becoming associated with Ralph Modjeski, consulting engineer, of Chicago, in 1899. After four years with Mr. Modjeski, Mr. Stevens entered the employ of the bridge department of the Northern Pacific, and four years later he became bridge engineer.

W. L. DARLING, whose resignation as chief engineer of the Northern Pacific Railway was noted in last week's issue, will in the near future open consulting offices in St. Paul for the practice of general railway engineering and construction. Mr. Darling's experience in his field covers a period of thirty-seven years. His first employment was in 1879 with the railroad from the head of whose engineering department he has just resigned. Three years later he went to the St. Paul & Northern Pacific Railway as resident engineer, from there to the Chicago, Burlington & Quincy and then to the Florida Railway as locating engineer. Mr. Darling turned his attention to the solution of terminal problems in 1885 and for the next two years was in charge of the Chicago terminals of the Chicago, Burlington & Northern. A brief experience as chief engineer of the Duluth, Watertown & Pacific preceded his appointment with the St. Paul, Minneapolis & Manitoba in 1887, which he left two years later to return to the Northern

Pacific as assistant engineer. He was soon promoted to principal assistant and later to assistant chief engineer and in June, 1901, was made chief engineer of that road. Three years—1902 to 1905—were spent as chief engineer of the Rock Island system and a few months of 1905 as chief engineer of the Pacific Railway. Early in 1906 Mr. Darling returned to the Northern Pacific as chief engineer.

CARL H. REEVES, consulting civil engineer, of Seattle, has been retained by the city of Bothell, Wash., to handle matters pertaining to municipal improvements, particularly paving, which is now before the council of Bothell.

A. B. CLARK, assistant engineer maintenance of way of the Pennsylvania Railroad at Philadelphia, has been promoted to succeed J. M. James as superintendent of the Renova division. Mr. Clark's promotion comes after twenty-seven years of continuous service with the Pennsylvania, whose employ he entered in 1889.

C. H. NIEMEYER, formerly division engineer at Pittsburgh, has been made assistant engineer maintenance of way of the Pennsylvania Railroad at Philadelphia, to succeed A. B. Clark, promoted.

HERMANN A. PHILIPPI, formerly superintendent of construction in the U. S. engineer's office at Vicksburg, Miss., has been made superintendent of the Miller Engineering Company of Little Rock, Ark. He will have charge of the construction of dam 2 on the Ouachita River, Louisiana. Mr. Philippi previously had charge of construction on the Big Sunflower River, Mississippi.

AUSTIN H. REEVES, of the New York office of the Southern Power Company, has been promoted to fill the position made vacant by the transfer of E. A. Van Deusen, noted elsewhere in this issue.

C. N. PHILLIPS, formerly assistant engineer to T. W. Jaycox, consulting engineer, of Denver, has joined the forces of the Morgan Engineering Companies at Dayton, Ohio.

## Obituary Notes

MAJOR WILLIAM G. RAMSAY, a vice-president and director of E. I. du Pont de Nemours & Company and chief engineer of its construction department, died Sept. 28, at Wilmington, Del. He was the principal factor in the physical development of the du Pont plants caused by the extraordinary demands put upon the company by the European war. Major Ramsay built many explosive factories throughout the country and recently was engaged in the construction of a plant in Montana which will be named in his memory. He was born in San Francisco in 1866 and was graduated from the civil engineering department of the University of Virginia in 1887. His first engineering work was as division engineer on the Chesapeake & Ohio Railway, which was followed by his appointment as resident engineer on the Baltimore & Ohio Railroad. His first connection with the powder business was when he became general agent for the Repauno Chemical Company, makers of high explosives. During the Spanish-American war he joined the engineering corps and rebuilt many bridges and roads in Porto Rico, for which he was promoted to captain and later to major.

JOHN CAMPBELL OLIPHANT, civil engineer, formerly of Trenton, N. J., died at his home in Toledo Sept. 29 at the age of 69. He was for many years employed by the Pennsylvania Railroad and was at one time resident engineer of the Pittsburgh division of the Baltimore & Ohio Railroad. He had also taken part in railway construction in Mexico. For the last few years Mr. Oliphant has been associated with the engineering department of Toledo.